POWER

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Are You in the Federation?

THE engineer won the war, but two newspaper men are nominated against each other for the Presidency.

The engineer designs the product, routes it through the shop, and conducts and oversees the complicated processes of production, but the salesman and the financier sit upon the board of directors.

The engineer has expert knowledge of most of the problems of government, national and local. In the Sixty-sixth Congress there were 334 lawyers, 76 business men, 26 journalists, 12 farmers, 13 bankers, 4 engineers and a scattering of other occupations.

Ask the next ten men you meet to name the leading citizens of their communities, and see how many engineers are mentioned.

The submergence of the engineer is nobody's fault but his own. He has been content to be the hired man and let the paymaster's name be on the doorplate. His habit has been to sit quiet in meeting, and let the lawyers, doctors, bankers and business men do the talking.

To change the nature of the engineer, to enhance the public estimate of his status, will take more than time. Public recognition will follow upon public service, if the public, which is fickle and inattentive, knows who renders it.

The engineers can become articulate and be mobilized for collective public service through organization, and a federation of engineering societies is in process of formation. An account of the organizing congress appeared in Power of June 15, pp. 978, *et seq.* It will succeed if it has behind it a live, quickened, impelling constituency, of which it is the mouthpiece and executive. It will not succeed if it is to be an aggregation of higher lights appointed by preferment and left to try to work out some service which will warrant its continued existence. The united collective interests, the inspiration and incitement of a constituency that knows what it wants done and is watching to see it done, and responsive to every suggestion for supporting action, will make it go.

And if it goes by doing things for the profession of engineering, it will carry you along with it if you are an engineer. It will cost the members of its constituent local societies one dollar a year each. Is it worth this to you ?

This is the engineer's opportunity. He was never so much in the public eye, never the subject of so much public encomium. It is time to act, and the action has already started. If you want it to succeed, your cue is to get your own association to join the federation, and if you do not already belong to an association, club or society which is eligible, join one or organize a local, and help to mobilize the hundred-thousand and more engineers of America for public service and their own welfare.

Reconstruction of a Power Plant Under Operation

By THORLEIF FLIFLET
Designing Engineer, Walter Kidde & Co., Inc.

AN INTERESTING job of boiler replacement work has recently been completed in the plant of the Surpass Leather Co., Philadelphia, Pa. Power production was maintained at normal over the entire period, during which a battery of seven old return-tubular boilers was replaced, two at a time, by three water-tube stoker-fired boilers. This work covered not only boiler replacement, but the elevation of the boiler-house roof, reinforcement of the old stack, the installation of new breeching, the erection of a 60-ton coal-storage tank above the boilers, and a vertical bucket-type coal conveyor to fill this tank. Fig. 1 shows the old boiler-room equipment in the foreground.

FIG. 1 THE OLD END OF THE BOILER ROOM IS SHOWN IN THE FOREGROUND

A shutdown of the plant would have entailed a loss of many thousand dollars a day. Owing to the necessity of uninterrupted operation and the general cramped condition of the boiler house, the obstacles to be overcome were many.

The system, under the original condition, consisted of a battery of seven horizontal return-tubular boilers of 150-hp. rating, built in 1900, and equipped with overfeed stokers. These boilers completely filled the boiler house. The roof of the latter was set so low that all the steam headers ran through the trusswork. The coal handling was of the crudest type, the coal being dumped from carts on the floor in front of the boilers. It was impossible to use automobile trucks for this purpose without another handling of the coal, inasmuch as they could not be backed into the fireroom. Ashes were wheeled in barrows to an elevator for filling the ash bin. A maximum steam pressure of 110 lb. was carried. Normal evaporation from and at 212 deg. F. was 5.6 lb. of water per pound of coal; the latter averaged about 13,000 B.t.u. per pound.

The primary reason for the replacement of this plant was the fact that the boilers would not pass insurance-inspection regulations because of their age and general obsolete condition. An incidental reason was the need for increased production.

After an investigation of the plant it was decided that the existing boilers would have to be torn out and replaced in separate units. There was no available land for the erection of a new boiler house, which construction would probably have been the simplest solution of the problem in the end. As a result of the investigation a decision was made to install three 500-hp. water-tube boilers, one of these to serve in general as a reserve unit. The question of using the old overfeed stokers or replacing them with the multiple-retort underfeed type was ultimately settled by the decision to use the old stack, after suitable reinforcement of the base to allow for the new breeching required. It was only with a forced-draft stoker that this was possible. Had natural-draft stokers been used, the construction of a

new stack would have been necessary to care for the extra rating in boiler horsepower which was desired. The existing stack was 150 ft. high and 6 ft. 6 in. in diameter.

On account of the increased height of boiler house required by the new water-tube boilers, and to allow for the erection of the proposed overhead larry track above the boilers, the roof had to be raised approximately ten feet with a corresponding increase of the height of all four walls. Steel ventilating sash to replace the old wooden sash were installed in the front wall to improve the lighting facilities in the new plant. The running of the steam headers from the old boilers through the trusses presented complications that had to be overcome by installing temporary headers at a lower level to extend below the trusses and to allow for complete freedom in raising the roof on its truss supports. Fig. 2 shows a sectional view of the plant after the new equipment was installed. Prior to the demolition of the old boilers, two temporary, hand-fired boilers of approximately 100 boiler horsepower each were installed in the yard and connected into the main steam header by temporary lines, suitably covered. With these boilers operating as substitutes for boilers 6 and 7 at the end of the original battery, the latter boilers were torn out and the foundation laid for the first unit of the new battery. The coal-storage bin was then erected, with its elevator, which was of the vertical bucket type. The elevator pit was installed in the boiler room. Under the new operating conditions this elevator pit is supplied either by dumping the carts or the automobile trucks through a sidewalk grating. From the overhead storage bin coal is delivered by a motor-driven traveling weigh larry of 2,000 lb. capacity, with a spout to discharge directly to an extended hopper on each respective stoker. Fig. 3 shows the foundation for one of the new boilers.

The first new boiler, the storage bin, larry and track were all installed at the same time so that they would constitute a complete operating unit and be ready for service before demolition was begun on any of the other boilers. Then, maintaining steam by the new 500-hp. water-tube boiler, and boilers 1, 2 and 3 of the old battery, boilers 4 and 5 were demolished and the second water-tube boiler of the new battery installed complete with fittings, etc., ready for operation.

The next step was to operate the two new boilers for the entire plant requirements, cut out old boilers 1, 2 and 3 and demolish the latter two; the third new boiler was erected to take the place of these. Boiler No. 1 of the old battery was left in place until the new battery was complete and operating. Then it was demolished and the foundation laid ready for a possible additional boiler at some future date.

During the work of demolition of old boilers 2, 3, 4 and 5 and the erection of the new boilers the two temporary boilers in the yard were kept ready for service with steam up, as a reserve should an accident occur to the operating units.

In carrying out this replacement work one of the most difficult jobs was to cut in the new breeching for each successive new boiler without affecting the draft conditions in the other operating units. After the reinforcement of the base of the stack, the opening for the new breeching was cut in and sealed temporarily.

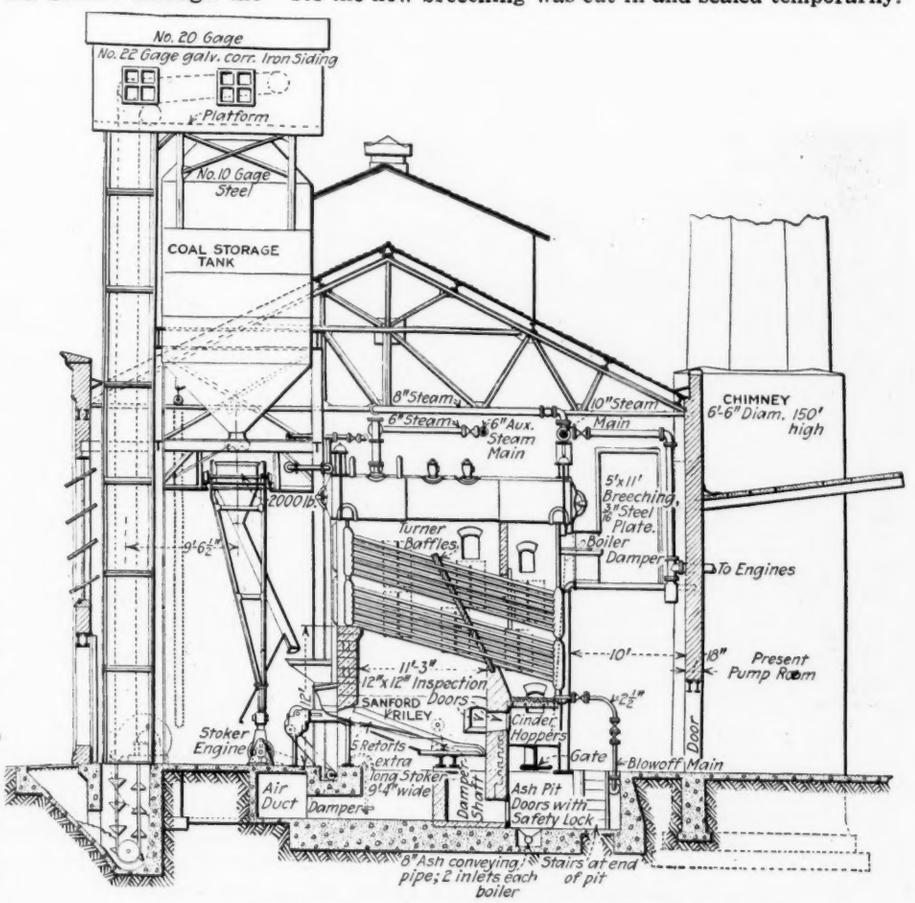


FIG. 2 SECTIONAL VIEW OF THE REMODELED PLANT

The new breeching was then constructed to provide for each boiler as it was erected. When this was completed, it was then but a question of knocking out the seal left in the breeching at each boiler to cut the boiler into the stack and into draft series with the other operating boilers. It was simple to leave the original breeching in place for the old boilers, as it was fortunately possible to place the new breeching above the old.

The question of feed-water heating and obtaining suitable makeup feed for the remodeled plant involved considerable revision of the old system. Under previous conditions no means of water treatment had been installed. Boiler-feed water was taken from the same feed-water heater (open type) that supplied process water for the tanning plant. Owing to the variable quality of the Philadelphia water in this locality, considerable scale was deposited. It was, therefore, decided to install a feed-water treating system for all necessary makeup feed. An open feed-water heater, was decided upon to serve the boiler plant only, and all condensate

was led to this heater. The original open-type feed-water heater was arranged for the sole purpose of furnishing hot process water for general use in the tannery. This water was heated by the main engine exhaust. This revised boiler-feed water system under maximum conditions is based on 8,000 gal. an hour requirements for day load, and 2,000 gal. per hour for night operation. The water-heating system has been constructed so as to be interchangeable with the pump suctions, so that in case either heater should fail it would be possible to swing to the other to supply the plant requirements.

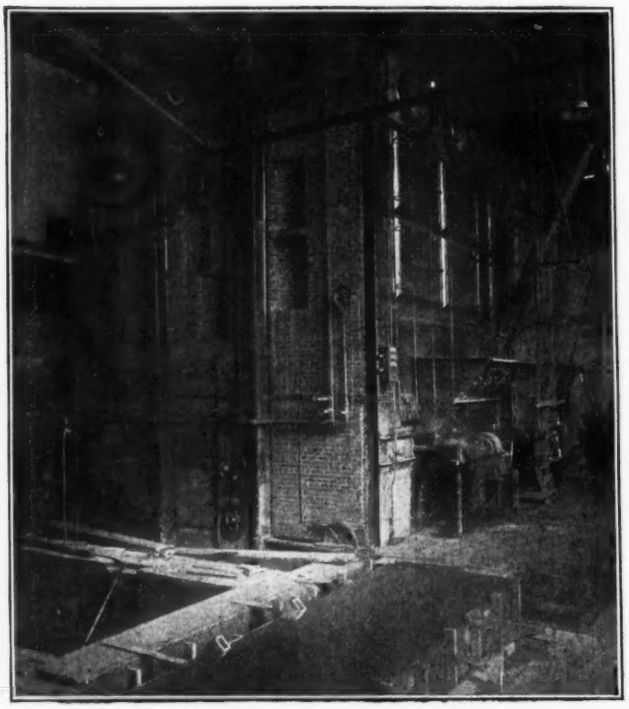


FIG. 3 THE FOUNDATION FOR ONE OF THE NEW BOILERS

Ash handling in the reconstructed plant is carried out by means of a standard steam ash conveyor with outlets adjacent to the ashpit doors in the bridge wall. No basement construction was necessary in laying out this system, as the cross-section of the boiler room shows. Ashes are discharged to an overhead ash bin and run by gravity through a chute to wagons or automobile trucks on the sidewalk.

Forced draft is effected by a duplicate blower system; that is, one small, 50-hp. turbine-driven multivane blower, and one engine-driven plate blower. A forced-draft volume of 30,000 cu.ft. a minute is obtained with one unit operating; the other is held in reserve as a spare for emergency.

Under revised operating conditions, two boilers are operated at 150 lb. steam pressure; the third is kept as a reserve unit. The present normal load averages 1,400 boiler-horsepower with a peak load of 1,800; the normal load for the old plant was 1,200 with a possible maximum of 1,400 attainable. Two water-tube boilers as operating at present under forced-draft conditions with the stoker system develop 150 per cent rating, or 1,500 boiler-horsepower with a possible maximum of 200 per cent rating. The fireroom force is reduced from five to three men on the day shift, and from three to two on the night shift. Today this plant, under the able supervision of Chief Engineer Louis Fletcher, of the Surpass company, is showing an increase in efficiency of more than 25 per cent over the former plant. An average evaporation of 10 lb. of water to a pound of coal is a general feature.

The revised design and construction of this plant were carried out by Walter Kidde & Co., of New York City.

The Public Estimate of the Engineer

The public is beginning to see the engineer; witness the following editorial from the Lexington (Ky.) *Leader*:

"Outside of the professor and the captain of industry few people realize the evolution that has come in engineering. Plain humans have evolved but slowly in a half century, but today you find the engineer everywhere.

"In all walks of production and industry except, perhaps, the industry of farming, the engineer is called in first. Few capitalists will risk their money, and time, on a project until competent engineers have gone over the ground thoroughly and endorsed it. Indeed, it is now a large practice for engineers of ability to seek out independently opportunities for the investment of capital or for the utilization of natural resources. Herbert Hoover himself is one of the successful examples of this latter class, who are sure to grow in numbers and influence every year.

"The engineer is becoming so important, as a matter of fact, that the day may not be long distant when he will take first place in industry and progress, the place occupied for centuries by the capitalist.

"And will not the world be a better place for humans when that happens? The capitalist sits in his office by day, the lord of all he surveys, and at night associates with his own class. His chief affair in life is how to make money and how to spend it. In most cases he is totally materialistic—not entirely because he wants to be, but because his environment and habits of life restrict him. He is cold spiritually because he doesn't mingle personally with the world's throngs. Thus when a problem comes to him involving masses of people, he naturally trends to the materialistic side.

"But the engineer! The very nature of his life's work carries him daily among the people, where he sees their problems, where he is often compelled to live as they live, work as they work and take risks that they take.

"It is easy to recognize which man should have first place in this worldful of human beings—the capitalistic captain of industry or the engineer."

A part of the exhaust steam from an engine should be used for heating purposes and for heating the feed water to the highest temperature, not less than 190 deg. F. in any event. The exhaust main should grade in the same direction as the flow, be drained and trapped and the condensation returned to a feed-water heater after filtering through a separating trap in order to prevent any grease or oil from entering the feed water and making its way to the boiler, as oil will decrease boiler efficiency and is dangerous as well.

Use no live steam at any time where exhaust can be utilized.

Operation and Adjustment of Turbine Machinery-II*
Putting a Machine in Service

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

"ALL those machines running with scarcely a man visible." Such is the comment of many who visit turbine-driven plants. This kind of machinery seems better fitted to take care of itself than other kinds. Inspection can be done by one man at regular intervals, while in the meantime the machines attend to their own business in their own way.

Efficient production of power is a matter of design plus intelligent execution. Regulating steam and water valves requires an understanding and judgment which

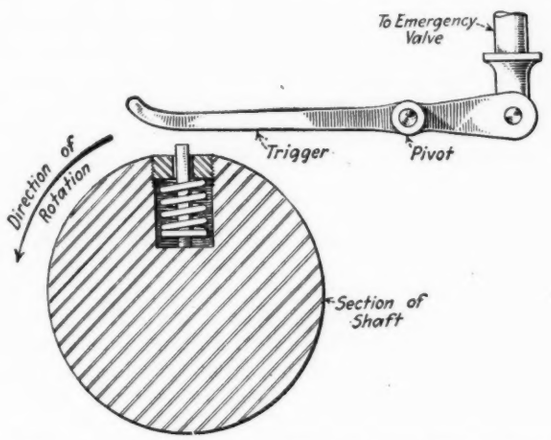


FIG. 1. USUAL FORM OF EMERGENCY SPEED TRIP

can be acquired with instruction and practice. Operating does not appear to involve deep and responsible problems.

However, if a shutdown of the plant should occur, the matter would appear in a different light. Quick action and hard work would be the order until the load was again restored to the plant. A total shutdown might not cost much as actually charged up to loss, but the ultimate effect on the plant might be so great that it could not easily be expressed in figures. The most efficient plant would have to suspend business if shutdowns occurred at frequent intervals, stopping all industrial activities in a community. Most plants would prefer to lose considerably on efficiency rather than a small amount due to a shutdown. The greatest element in operating appears to be the production of power in a dependable way. Manufacturers spare no pains to insure reliability; the salesman dwells on it and the purchaser banks on it. It is up to the engineer to deliver it.

The machinery is often too expensive to be bought in much greater capacity than actually required. Repair work must frequently be done as the load permits, and the engineer is thereby forced to act quickly and to the point. His task is somewhat heavier than listening to the hum of machinery.

*The first article of this series, in the July 6 issue, took up placing the turbine on its foundation.

Placing a machine in operation for the first time is one of the most important steps of operation. This not only includes bringing the machines up to speed and building up load, but with it goes the responsibility of making sure that the machine is in proper condition so that there will be no risk of damage. If a small machine of about 100 kw. or under is ready to be started, the routine would shape itself as follows: (1) Inspection of foundation, supports and piping; (2) clean thoroughly; (3) fill with oil; (4) inspect mechanical condition and adjust; (5) warm up; (6) start and bring to speed; (7) apply load and carefully observe.

When inspecting the foundation, make sure that the grouting is solid, also of the proper thickness, which should be ⅜ in. to 1 in. between the bottom of the bedplate and the top of the foundation. Grouting inside of the bedplate should be as thick as can conveniently be made.

Piping should be supported so that little strain is carried on overhanging parts such as valve chests or exhaust heads. Usually, 200 to 400 lb. is all the strain that is necessary at any time, and with proper supports it can easily be made less. Expansion should be taken care of by flexible joints or flexible arrangement of piping. In some cases the piping can be anchored at the

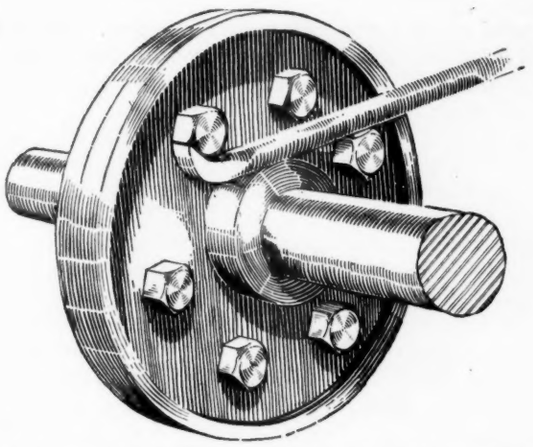


FIG. 2. TURNING MACHINE WITH BAR AT COUPLING

turbine and provided with rollers so that it is free to expand in a direction away from the turbine.

The steam line should contain a drain close to the throttle as well as a strainer for keeping solid objects from entering the turbine through the steam line. The exhaust header should be designed so as to be free of water. If a machine is condensing, see that an atmospheric relief valve is provided through which the exhaust may blow in case the vacuum fails. In some installations with a jet or barometric condenser, the exhaust, under such conditions, would blow freely through the condenser, so that a relief valve would not

be absolutely necessary. However, it is better practice to have one so that the relief will be instantaneous.

When cleaning, be careful to follow up splashes of concrete from the grouting so that this will not be left in delicate parts of the generator or the oil system. Dirt and cinders are likely to be carried into the machine during shipment. Loosely covered parts and small spaces should be inspected closely with this in mind.

Look over the generator windings and polepieces carefully with an extension light to make sure that

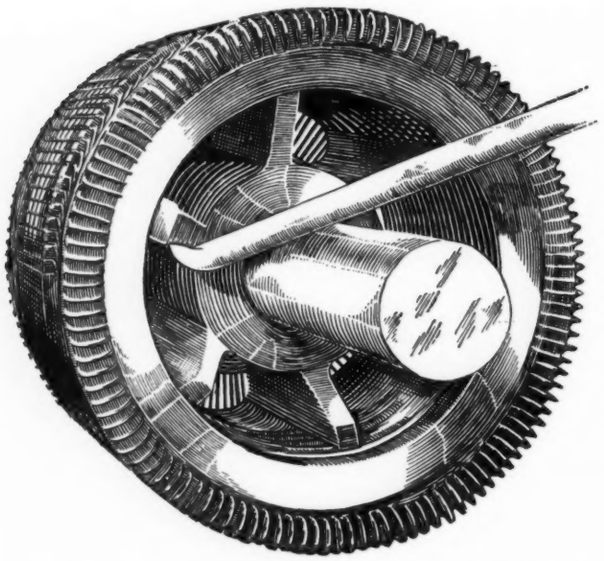


FIG. 3. TURNING ARMATURE WITH BAR INSERTED IN SPIDER

no solid objects are left in the machine. Tools and bolts have been left in this manner with the result that costly damage was produced when the machine was put in operation.

Fill the machine with oil of the proper quality. There is an oil pocket under each bearing as well as a reservoir and, in some cases, a large pumping chamber beside this, which must all be filled with oil. As it is easy to skip one of these pockets when filling with oil, it is advisable to locate all of the oil-system gage-glasses. If one of these pockets is not filled, the oil level will become lower when the pump goes into operation. As soon as this is completed, look over the oil system for possible leaks. There is often a strainer in the oil system, and this should be cleaned before filling and also after the first day's run, as waste and other impurities are likely to clog the strainer when the machine is first started.

In small machines the clearance between the rotating and stationary parts is set in the factory and usually can be depended on to be in good adjustment owing to the rigid construction of small machines. Peepholes are usually provided in the turbine casing for the purpose of observing and measuring these clearances. This examination, together with turning the machine over by hand (see Fig. 2), should be all that is necessary. Clearances in the generator should be looked at with a drop light. Usually, these are correct, but if this should be a special case where they are appreciably unequal, the clearance should be measured from one spot on the rotor to several points on the stator, by revolving the rotor so that the marked spot comes to each point of measurement in turn. With direct-current generators this should be correct within 10 or 15 per cent. Measure to centers of pole faces.

The governor and valve gear should be carefully inspected. If the valve gear is controlled by a steam or hydraulic cylinder, the pilot valve should be disconnected and moved by hand to make sure that there is no sticking. Friction of all kinds must be avoided, including mechanical friction between disk and cylinder of the dashpot, if there should be one.

The overspeed emergency trip should be set and tripped by hand a number of times. It is most important to see that this mechanism works freely. Fig. 1 shows a sectional view of the usual overspeed emergency trip for small turbines.

If there is reason to suspect dirt in the main bearings, they should be looked into. Ordinarily, the test of turning the machine over by hand is sufficient.

When turning over, it is generally easiest to use a small bar about two feet long. Pry between the shaft and a coupling bolt or the inside of the armature spider (see Fig. 3) or some other equally solid part. Be careful not to touch the generator windings, commutator bars or other delicate parts with the bar. Always turn in the direction of rotation. This can usually be ascertained by looking at the trigger arrangement of the emergency trip. The trigger extends from its pivot in the direction of rotation.

If cooling water is supplied to the oil system, this should be tried out. Note if the overflow piping is large enough to carry the water off fast. See that there is no splashing which can be carried into the generator by air suction. If the machine is equipped with a vacuum breaker or other auxiliary devices, they should all be tried out to make sure that they are in good condition.

Before warming up the machine, blow the scale out of the steam pipe. There should be a drain close to the throttle valve which can be used for this. If the drain is trapped, disconnect the line temporarily so that the drain will freely blow. If there is no suitable drain, open up a convenient pipe joint or remove a blank flange so that the pipe scale can be thoroughly blown out. Go over the exhaust line to see that all valves are open. If the turbine is condensing, turn on the steam which seals the packing rings and start the condensing equipment. The turbine casing drains should be well opened. Make sure that the atmospheric relief valve is in good working condition. In case the machine is noncondensing and exhausts into a main with back pressure, the exhaust valve should be slowly opened to allow the exhaust steam to warm it gradually. After this the throttle valve can be used to warm up a little more.

Just before starting, trip the emergency valve by hand and drain the steam line. This is a precaution that should always be taken just before starting a machine. Turn on enough steam to start the turbine. Allow it to speed up a small amount and then shut off the steam. Listen at several points on the wheel casing in succession to see if there is rubbing between rotating and stationary parts. A good way to listen is to place a rod or piece of pipe on the turbine casing and touch the ear to the other end of the rod. Some men hear or feel better by touching the teeth to the rod. Clicking from the valve gear and oil rings is usually heard, but a rub has a strong metallic ring that is unmistakable, and usually loud enough to be heard without a rod.

Next look at the oil rings in all bearings to see that they are turning properly and carrying oil.

Allow the machine to slowly accelerate. Watch the temperature of each bearing by feeling the liner itself. Also observe closely the amount and temperature of overflow oil from each bearing if it is possible to see this. If the overflow is not accessible, gage the temperature by feeling the return oil pipe from each bearing. Watch the oil-pressure gage as the pump picks up the pressure, and be prepared to regulate the pressure at the relief valve for this purpose. Small machines usually require 3 to 6 lb. per square inch oil pressure, while larger ones run 8 to 20 lb. The oil pressure should be as low as is consistent with safety. The reason for this is that oil will last longer at the lower pressure.

Final adjustment should be made when the machine has reached its highest temperature under load, as the oil is then thinnest and pressure for a given setting of the relief valve is lowest. It is best to consult the manufacturers' instruction book for actual information, and it is the best policy to use an oil pressure that will have two or three pounds in excess of the minimum for good operation. Carefully watch the oil level in case it happens that any important part of the oil system is left unfilled. The bearings close to the turbine generally run hottest on account of the shaft being heated by the steam. In some machines such bearings have been known to run constantly at a temperature of 90 deg. C. or 190 deg. F. Judge the condition of the bearing by the speed with which it heats rather than by the actual temperature. A tight bearing will reach boiling temperature about as soon as the machine will reach full speed, and in some cases, even more quickly than this. It usually takes about half an hour to reach a constant running temperature under proper conditions.

Let the machine accelerate slowly until normal speed is attained. Watch the valve gear closely as the governor goes into action. In case the machine should keep on speeding after the governor has acted, it would indicate improper seating of the valves or bad adjustment of the valve gear.

After an hour's run at full speed, the emergency governor should be tested. Hold a tachometer on one end of the shaft so that the speed can be read by an assistant. Make the macnine overspeed slowly by pulling against the governor or by disconnecting some part of the valve gear so that a valve will be held open. The emergency trip should shut the machine down at 10 per cent above normal speed. It is usually safer and more practical to adjust this emergency to shut down at 6 or 8 per cent above normal. If the emergency trip is too close to normal speed, the machine will shut down when the load comes off suddenly on account of a circuit breaker tripping out.

The generator can now be put into action and the machine run under load for several hours, during which it should be carefully and constantly observed.

(The next article deals with directions for examining and starting large turbines after their erection.)

Trouble-Hunting in Refrigerating Plants

BY J. C. MORAN

An incompetent crew lets a plant get in such condition that only about one-half capacity can be had from it. The owners are nearly ready to buy more machines when they call in an engineer troubleman. Under his direction the present equipment is made to give more than adequate capacity. What he finds and does is told in the article.

THE installation consisted of two 100-ton single-acting twin-cylinder machines, two double-pipe condensers, and direct-expansion coils in most of the rooms. A small brine cooler was installed for brine circulation in part of the rooms. The owners were having a lot of trouble in getting enough capacity out of their refrigerating machinery. There was no license law either in the little town where the plant was located or in the state, and as a consequence he who could get a job was an engineer, getting the job being, in most cases, a matter of agreeing to work for the smallest wages.

ENGINEER AND CREW INCOMPETENT

This was also the case in this plant. The engineer had formerly been assistant in the flour-mill plant in a near-by town, but not getting along very well with the chief, had quit and gone back to farming. When the new cold-storage plant was built, he applied for the job and with his flour-mill experience to back him he got it, mainly because he was willing to work long hours for small wages. The manufacturers recommended a man for the job, but he would not take it under the working conditions and for the wages offered. A fireman was obtained that previously had been firing in the flour mill, and he was put in charge as night engineer. A couple of laborers were hired for firemen.

The erecting engineer remained on the job for about two weeks after the plant was in working order and showed them as much as possible about operating it. When he left, the new chief and night engineer were confident that they could operate the plant satisfactorily and that nothing would happen that they could not take care of.

AS LOAD INCREASED OPERATION BECAME UNSATISFACTORY

The machines had about double the capacity required when the plant was first started, and for a long time it was necessary to run only one machine, even during the hottest part of summer. However, the load increased until it was 40 or 50 per cent greater; this was at the end of three years. By this time the machines were running as fast as they dared to run them and still the temperatures in the rooms were far too high. The engineers claimed that there was nothing else to do but get more machines.

Happening to be in the town on a case of trouble with a small machine in an ice-cream plant, the writer met one of the owners and was asked to look the place over and give an opinion as to what should be done, and to make an estimate of the equipment that would be required.

The plant was in a bad shape. It could be seen without taking the machines apart that some of the valves were leaking, because they would lunge and yank like a pair of horses that do not pull together After figuring everything over several times, I somewhat surprised them when I told them that they had more capacity than needed at present. This I proved by their own records, which showed that they were handling only 40 per cent more goods than at the time the machines were started. And at that time one machine had been big enough for the load.

A New Chief the Best Remedy

When asked what could be done to remedy matters, I frankly told them that the best thing would be a chief who knew his business and who would have a free hand in overhauling the plant. I then gave them an estimate on what it would probably cost to overhaul the plant, which was quite a shock, but when convinced that this was a lot cheaper than to buy new equipment, they finally asked me to recommend a man for the job. This I did, and the new man was on the job a few weeks later. The plant was put on an eight-hour day basis and the two other men were kept working under the new chief.

This was in the middle of winter, and it was possible to handle the load with one machine by running it fast. The worse of the two machines was shut down and overhauled. The false head on one cylinder had probably lifted at some time and a piece of scale had stuck between the head and seat, keeping it open about $\frac{1}{16}$ in. around the greater part of the circumference. This accounted for the lunging action of the machine. The valves were also badly scored and the piston rings a loose fit in the cylinder. The seats were ground in both on the false heads and the valves and the piston rings

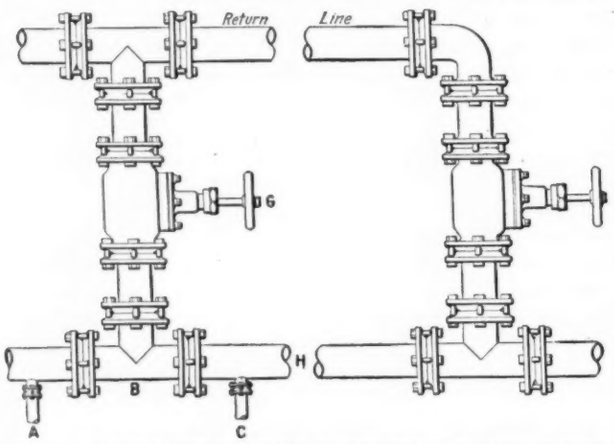


FIG. 1. A LIME-LIKE DEPOSIT PLUGGED THE CONDENSER-WATER CONNECTIONS AT *B*

peened to spread them slightly. The piston rods also were taken out and turned true, being slightly smaller in the center and scored from the three years' wear. The old crew had been liberal with oil and packing, and the wear on the machines all around was really less than one would at first expect. Yet most of the oil used in the compressor and stuffing box had gone into the system and accumulated in the expansion coils, and this was largely the cause of the decreased capacity.

The bearings, steam cylinder and the rest of the machine were also gone over and adjusted and the steam valves reset. When again started, it seemed like a new machine. When put on the load, it handled the entire plant at reduced speed and the temperatures were held lower than had been the practice for a whole year before.

When the second machine was opened, it was found that the discharge valve had jammed about half open and probably had not worked for several months. At least the night man informed the new chief that this machine had acted like this for several months, but as long as they could keep going they had not dared to shut down and look into it. Besides, they were a little nervous about taking the machine apart, he told the chief.

On the other cylinder one of the screws that held the suction-valve seat in place had worked out and

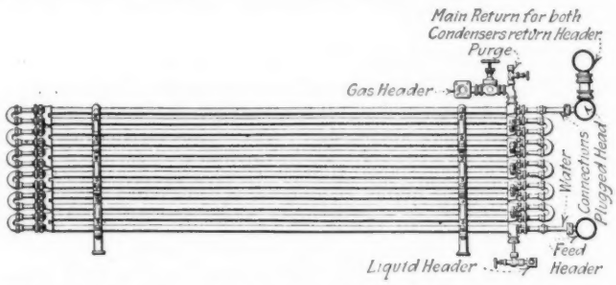


FIG. 2. A SPLIT PIPE IN THE CONDENSER HAD ALLOWED AMMONIA TO BLOW INTO THE COOLING WATER

evidently at some time or other jammed between the seat and suction valve, making a heavy dent in the seat and slightly warping the valve. Of course a large proportion of the gas handled had leaked back through this opening, and it is a wonder that the machines had done as much work as they did under the conditions. When the work was finished on the second machine, the result was just as favorable as on the first, and the load was handled easily with either machine.

Overhauling the Condensers

While the work was being done, the chief had been investigating the condensers. This was about midwinter, as stated before, and the water temperature was around 38 deg. The water was taken directly from the city main and pumped through the condensers to a laundry next to the cold storage plant which used all the water the cold storage plant could spare. Consequently, it was to be expected that the condenser pressure should have been pretty low, but it was about 200 lb. Both condensers were in service, too.

The chief cut out one of the condensers and purged it thoroughly two or three times. Then he cut it in and shut down the other. A few minutes later one of the men came rushing up on the roof where the condensers were located and informed the chief that the condenser pressure had jumped to 230 lb. and that they had shut down the machine.

They again started the machine and the condenser pressure came up to 225 lb. in a short time. Only by running the machine very slowly could the pressure be kept down to 200 lb., and it was left to run this way until the other condenser was purged, it being a fairly cool day, and the coolers would probably have been in good order if the machine had been shut down for five or six hours. However, they considered it better to keep the machine turning over slowly and get what they could out of it.

After giving the second condenser a good purging, the condensers were changed over again and this time the

pressure dropped to 110 lb. The condensers had never been purged since started, and this accounted for the high pressure, both condensers being full of air and foul gases. The fireman in particular was greatly pleased with the changed conditions as it made a material reduction in the amount of coal he had to shovel.

The next problem was to determine what was wrong with the other condenser. The new chief had an idea that the trouble was in the gate valve *G*, as shown in Fig. 1. When it was opened for inspection, it was found in good order. While inspecting this valve, however, one of the men noticed a white substance, like lime, just below it, and this was the cause of the trouble.

The Condenser-Water Connections Were Clogged up

The condensers were of the double-pipe type; the diagram illustrates the water connections to both of them. No. 2 was the condenser that would not work. The lime-like mass lodged at *B*, and this had practically closed the passage through the tee to the return line; *A* and *C* are the water-pipe connections to the two stands on either side of the tee.

The caps were removed from the ends of the water header *H* of this condenser, and with a long rod the obstruction was poked out. In doing this a strong flow of water was kept going and the line and header cleared in a hurry. When the condenser was again put in service, it remained at practically the same pressure as the other.

No one was able to account for the presence of the foreign matter in the tee, and no further thought was given to it at that time. About two weeks later this condenser was cut out for a thorough overhauling, and the first thing to be done was to remove the water-return bends on each stand, Fig. 2, to test the pipes for leaks. When these were taken off the stand, it was found that the pipes were filled with this same lime-like substance for several pipes down. This was poked out and the pipes run through with a tube scraper. When a pressure test was tried on this stand, it indicated a bad ammonia leak in one of the pipes. The pipe was removed, and it was found that it had split for about an inch and a half and allowed the ammonia to blow continuously into the water.

The ammonia had formed some chemical compound with the foreign matter in the water. This had filled up the pipe at the tee where it connected to the return, and with the increased obstruction nearly all the water had taken the less obstructed path through the other condenser until circulation through No. 2 had stopped, or nearly so.

Obstruction in Coil

In one of the rooms they had been unable to get the proper temperature for nearly a year. Originally, this room had maintained a temperature of about 15 deg. without much trouble, but for the last year they had been unable to keep it much below 40 deg. and they had been obliged to use it for storage for only high-temperature goods. The room had a single coil about 2,000 ft. long. At first, when a fair load was put into the cooler they had been able to open the expansion valve about half a turn without throwing liquid into the suction line. After the trouble appeared, it was possible to work it with the valve barely cracked, and even then it would sometimes throw such heavy slugs of liquid into the suction line that it would freeze the machines in a short while.

The new chief experimented with this coil and room for awhile without results. During the time he was making his experiments he noticed that the liquid level in the ammonia receiver bobbed up and down. If he shut this coil off and pumped it out he had the receiver full of liquid, and after he started the coil working he found that the liquid level in the receiver would drop out of sight. After studying the matter over for the better part of a week, he detected the cause of the trouble.

He came to the conclusion that there was an obstruction somewhere in the coil and that the most logical place to look for it was, of course, in the suction stop valve. When this was removed, it was found that the disc had worked loose from the stem, and as it had been placed in the line in the wrong position the flow of the gas through the valve had a tendency to pull the disc down on the seat instead of lifting it off, as would have been the case if it had been installed in the reverse position.

The disk had not seated squarely, but obstructed the passage enough so that when the coil was working a pressure was built up in the coil. This, in turn, raised the boiling point of the ammonia, and if the expansion valve was opened much the coil gradually filled with liquid. The feed was connected at the bottom, and as a consequence the coil filled nearly to the top with liquid. This was the reason the ammonia disappeared from the receiver when this coil was put in operation. After the valve was repaired, no further trouble was experienced.

Diesel-Engine Speeds

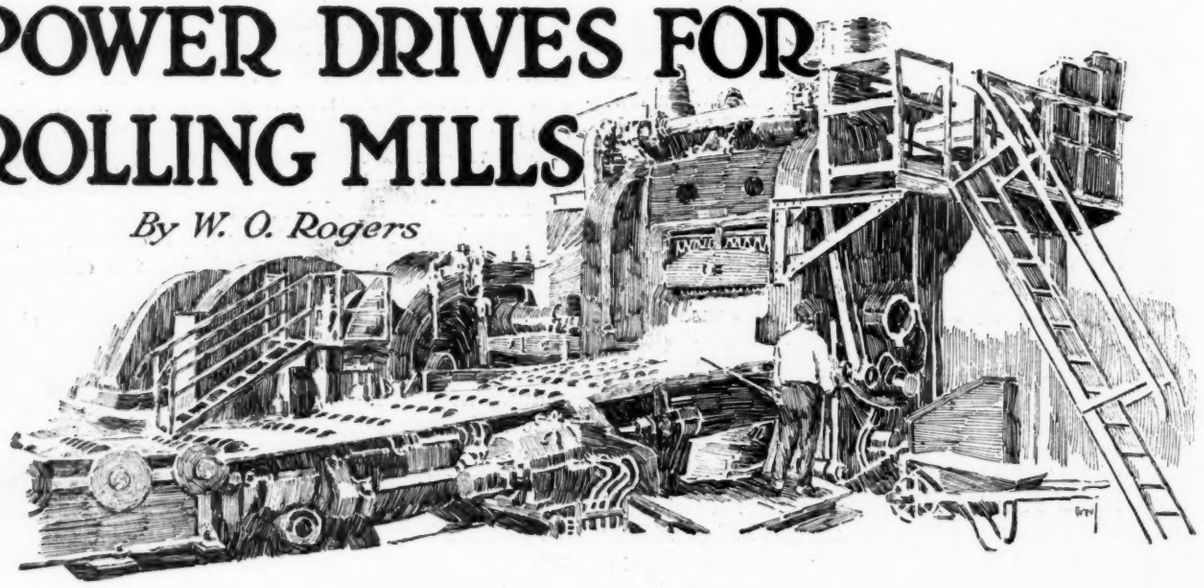
The Diesel-engine manufacturer is confronted by a decidedly dangerous competitor. In the last few years a number of surface-ignition engines have been built in sizes above 200 hp. One European concern has installed engines of 600 hp. and is now building a 1,000-hp. unit. These engines are cheaper to build and are rapidly encroaching on the Diesel-engine field.

If the Diesel manufacturer does not wish to lose that part of his business devoted to units under 500 hp., it will be necessary for him to increase the Diesel speed and thereby lower the manufacturing cost. There is no structural reason to prevent Diesel engines, when properly designed, from operating at speeds as high as 400 r.p.m. Units of 500-hp., if operated at 300 or 400 r.p.m., could be manufactured at one-half the present cost. The chief objection that might be raised would be that this speed would be impossible for the air compressor. The compressor could be motor-driven or abandoned altogether. Lighter valve rigging and reciprocating parts would reduce the frictional loss, which in the present-day Diesel is excessive. Marine Diesels have been designed to operate at the higher speeds; provided with a suitable foundation, this same engine would have a life equally as long as has the present-day ponderous slow-running machine.

With tight boiler settings, preventing infiltration of air, a clean heating surface, covered pipes, tight steam valves, pipes properly drained, and all condensation returned to a feed-water heater or economizer and using exhaust steam whenever it is practical, a good start has been made to prevent waste of fuel.

POWER DRIVES FOR ROLLING MILLS

By W. O. Rogers



Rolling mills are driven by both direct-current and alternating-current motors. Direct-current motors are operated at constant speed; so are the single-speed induction motors, but both types are also operated at variable speeds, a regulating set being used to control the speed of the main motor when of the alternating-current type.

AS IS well known, the first commercial use of electricity was for lighting, and it was next applied to street-car propulsion. It was not long, however, before it was introduced in industrial fields. Naturally, motor drives were tried out with some apprehension on the part of mill owners, but this soon gave way to confidence, and today there are something like 10,000,000 hp. in electric motors in use in the United States. In recent years great strides have been made in the application of motor drive to rolling mills, so much so that something like 900,000 hp. in motors, devoted to steel-mill practice, have been installed.

As with steam-driven mills, electrically driven main rolls are divided into three classes—single speed, three-high and two-high nonreversing mills, and two-high reversing mills. In the first and second class of mills they generally consist of a single stand containing three rolls, as for instance, mills rolling plate; or they may consist of a group of stands containing two rolls each, or three-high stands, such as are used in rod or merchant mills, and driven by a single engine or motor.

The third class of mill consists of a single stand containing two horizontal rolls such as used in reversing blooming mills, or a combination of two horizontal and two vertical rolls, as mentioned in the preceding article in reference to the reversing universal mill. These rolls may all be driven by the same engine or motor, or each set may be driven by a separate source of power.

Single-speed mills are generally driven by single-speed induction motors, largely because alternating current is distributed about the plant, but direct-current motors may be used. As in the case of engine drive, a flywheel is generally used to assist the motor in carrying the peak loads, which are high but of short duration. When flywheels are used, provision is made for controlling the motor by automatically cutting in or out resistance in the rotor circuit, when the load exceeds a predetermined amount. This causes the motor to slow down, and the flywheel then carries its part of

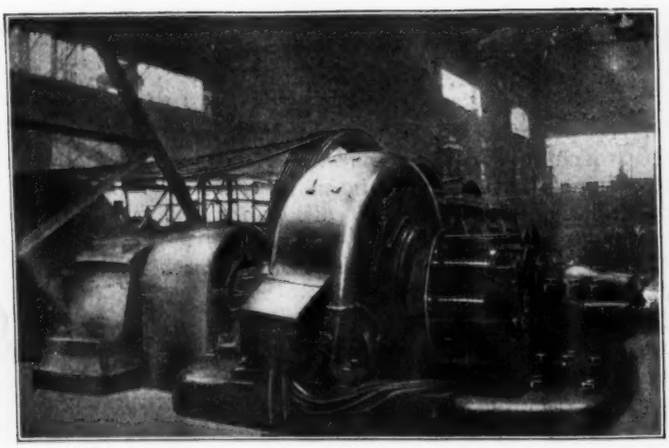


FIG. 1. A SMALL 500-HP. DIRECT-CURRENT MOTOR

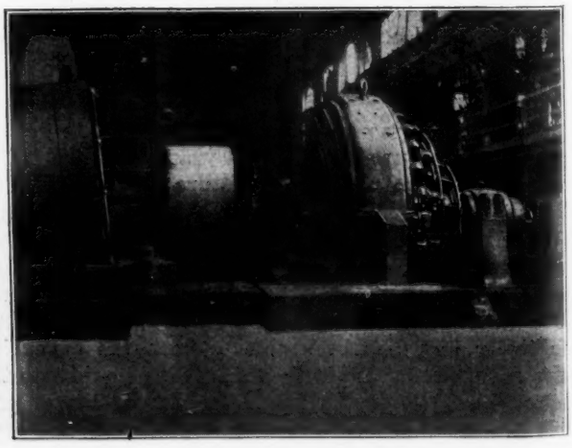


FIG. 2. A 1,500-HP. FLYWHEEL D.C. MOTOR

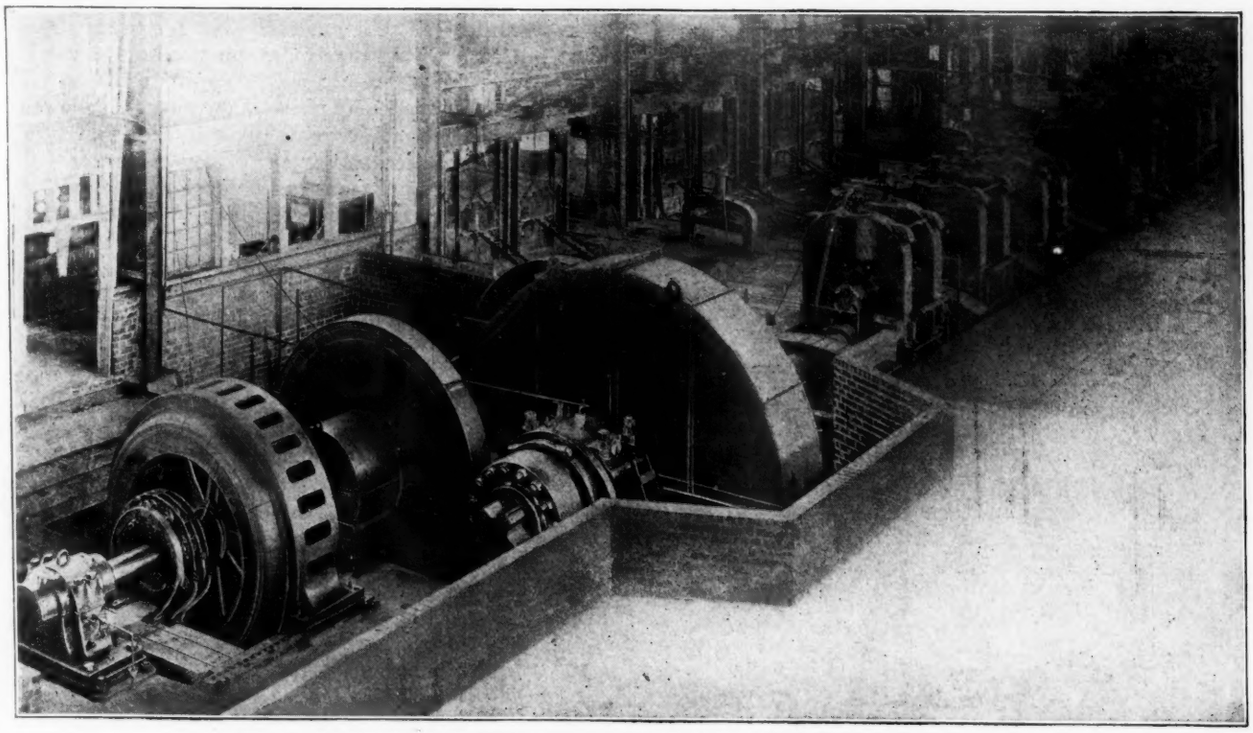


FIG. 3. DOUBLE FLYWHEEL INDUCTION MOTOR DRIVING A PLATE MILL

the load. The flywheel also reduces the shock which, if there were no flywheel, would be transmitted from the mill back to the motor.

In Fig. 1 is shown a small General Electric 230-volt, 500-hp. direct-current motor, with a speed of 190 r.p.m. It is of the flywheel type and operates the roughing stand of the 14-in. bar mill at the Sharon Steel Hoop Co., Sharon, Ohio. In this instance a rope drive is used. The 14-in. bar mill is driven by a flywheel-type, 230-volt direct-current motor, Fig. 2. It is of 1,500-hp. capacity and is directly coupled to the mill by means of a spring coupling.

A double flywheel unit shown in Fig. 3 consists of a Westinghouse induction motor of 1,500 hp. capacity running with a speed of 234 r.p.m. It receives current at 2,200 volts, 60 cycles. The motor has two flywheels, one being mounted on each side of the pinion. The inner flywheel is between the pinion and the coupling to the motor. The other flywheel is mounted on the end of the pinion shaft that extends beyond the outboard bearing. The herringbone pinion meshes with a large gear of like design on the roll shaft of this plate mill, which is at the Canton Sheet Steel Co., Canton, Ohio.

The motor is provided with a slip regulator which slows down the motor automatically during periods of heavy load, thus permitting the flywheels to give up their energy and reduce the peak load on the electrical

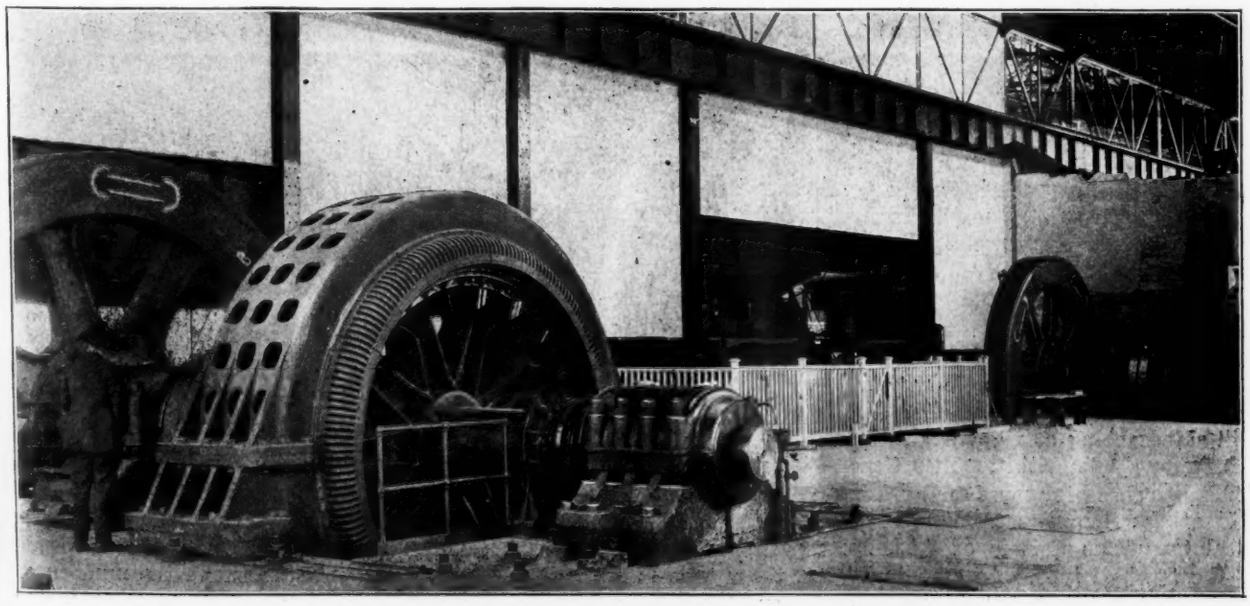


FIG. 4. TWO 2,000-HP. FLYWHEEL INDUCTION MOTORS

power system. It will be seen that the flywheels are arranged on the pinion shaft instead of on the mill shaft, which permits the use of comparatively light wheels with large flywheel effect. It is necessary to place the flywheel on the pinion shaft, because, in this type of mill, which runs at about 30 r.p.m., there would not be sufficient flywheel effect in the system if the flywheels were placed on the mill shaft.

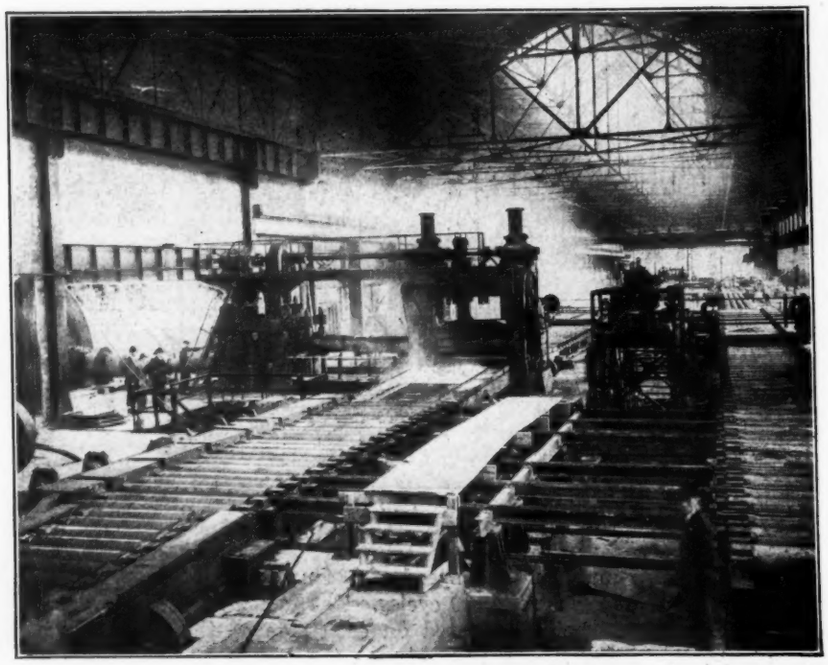


FIG. 5. AN 84-IN. THREE-HIGH PLATE MILL, MOTOR-DRIVEN

A view of the motor room of the 84- and 96-in. plate mill at the main plant of the Youngstown Sheet and Tube Co. is shown in Fig. 4. Both of these Allis-Chalmers motors are of 2,000-hp. capacity and are of flywheel type, operating at 81½ r.p.m. Both use 6,600-volt, 25-cycle three-phase current. These plate mills are shown in Figs. 5 and 6. Both are of the three-high type, and the rolls on the 96-in. mill are lifted by hydraulic pressure. The adjustment is by means of a motor drive.

A 3,500-hp. 78-pole General Electric induction motor was found operating the 18-in. sheet bar mill at the Trumbull Steel Co., Warren, Ohio. This unit, Fig. 7, runs at 92 r.p.m., with a voltage of 2,200. The motor drives the mill through gears, the mill stands being at right angles to the motor shaft. Still another General Electric motor of similar character was found driving the 110-in. plate mill at the Sparrows Point works of the Bethlehem Steel Co. This unit is of 4,000-hp. capacity and is of the flywheel type. As seen in Fig. 8, the flywheel is mounted on the shaft between the motor and the outboard bearing.

The flexibility of mill operation with electric drive has permitted a wide range of production and a variation in mill schedule that has been a factor in increasing tonnage. In three-high mills the adjustable-speed alternating-current motor drive gives a wide range of speed with a variation ranging in many cases down to 40 per cent. The equipment can be designed for either constant-horsepower or constant-torque requirements, but a majority of mills require approximately a constant horsepower. Fig. 9 shows a 1,500-hp. adjustable-speed alternating-current motor that is directly connected to an 18-in. merchant mill at one of the Carnegie Steel Co.'s plants; another one of the same capacity operates a 12-in. merchant mill at the same plant, and a 2,500-hp. unit operates a 16-in. hoop and bar mill at the Phillips Sheet and Tin Plate Co., Wenton, W. Va. This drive uses 6,600-volt current. The first two motors are 25-cycle, the latter two motors are geared connected to the mill, the speeds being 28-218-145, 360-240 and 176-352 r.p.m. respectively.

Although direct-current motors are used to drive adjustable-speed mills, the three-phase induction type of motor with phase-wound rotors is generally used. The stator winding is the primary and the rotor winding is the secondary. When voltage is sent to the primary winding, the alternating current in the coil builds up a magnetic field which revolves at a speed that depends upon the frequency and inversely upon the number of poles. In the secondary winding a voltage is generated which is a maximum when the rotor is at a standstill,

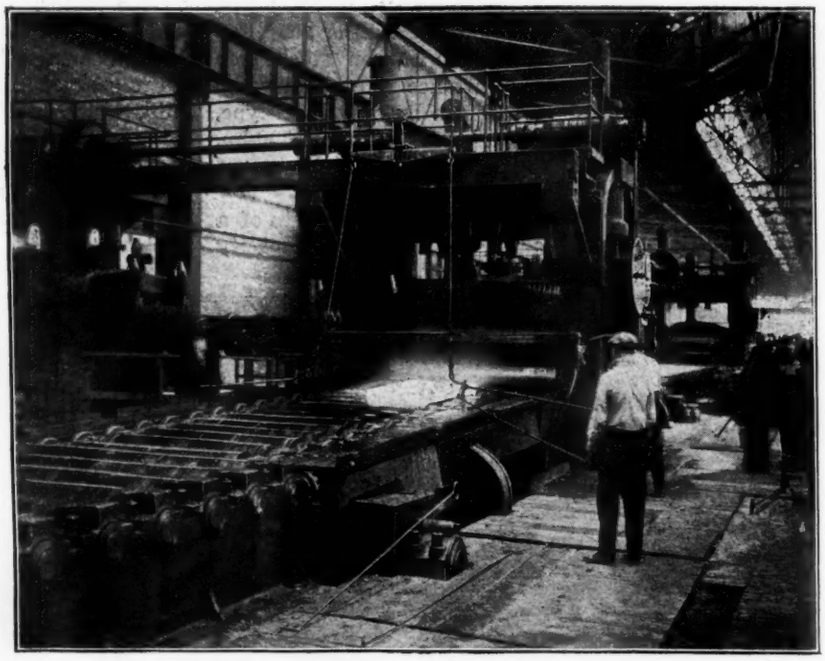


FIG. 6. A 96-IN. ELECTRICALLY DRIVEN PLATE MILL

and the secondary frequency is then the same as the primary frequency. The current flowing in the secondary winding exerts a torque that causes the rotor

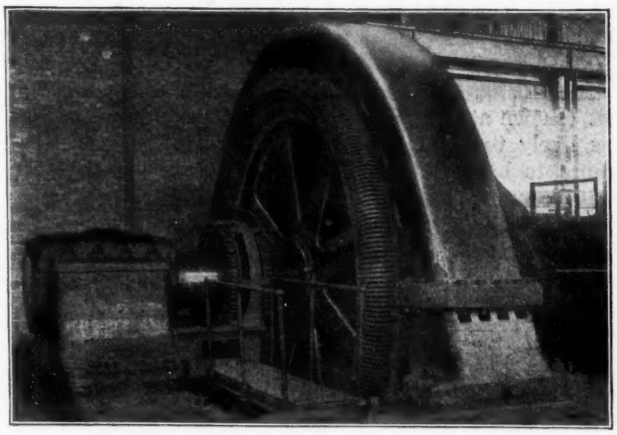


FIG. 7. THE 3,500-HP. INDUCTION MOTOR DRIVING AN 18-IN. SHEET BAR MILL

to revolve in the direction of the rotating field. The rotor speed continues to increase, but the secondary voltage and frequency will decrease until the secondary voltage is of a value to send sufficient current through the winding to produce the necessary torque. If the load remains constant and the speed of the motor is reduced by means of putting resistance in the secondary circuit, then at any other speed the voltage and frequency are practically proportional to the slip in percentage of the synchronous speed.

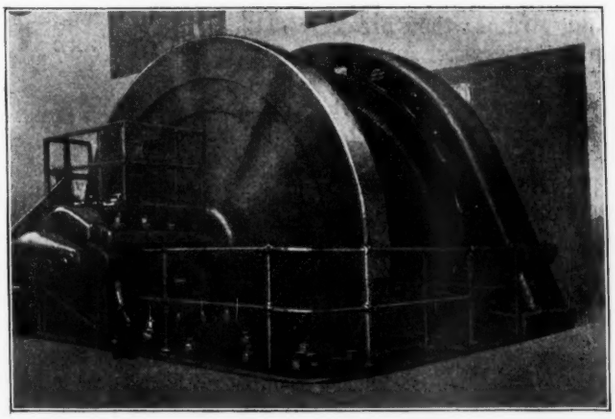


FIG. 8. A 4,000-HP. FLYWHEEL-TYPE INDUCTION MOTOR

But if a constant voltage at rotor frequency is used to oppose the secondary voltage, the rotor speed will adjust itself to such a value that the secondary voltage exceeds the opposing voltage by an amount equal to that necessary to send through the circuit sufficient current to develop the required torque. The speed of the motor can be changed by varying the opposing voltages if the opposing voltages are adjustable. A means of adjusting the voltage on the secondary winding of the main motor is provided in a regulating set. This regulating set consists of a squirrel-cage induction generator, and a direct-current machine, the induction generator returning energy to the line.

Induction motors are generally provided with magnetic control when speed-regulating sets are used, which provides for the proper interlocking of the various circuits. The control is so designed that certain operations must follow in sequence when starting the main motor when operating with the regulating set.

In starting, the master control which governs the operation of the contactors controlling the main motor must be in the off position. Next, the speed-regulating rheostat must be placed in the starting position, which corresponds to the setting at which the regulating machine generates no voltage. Then the regulating set must be started from a starting compensator by the squirrel-cage machine acting as a motor. The main motor may then be started with resistance in the secondary circuit, by the operation of the master controller, and this resistance cut out as the motor comes up to speed. Provision is also made for operating these motors without the regulating set if such became desirable.

A three-high finishing stand of the 84-in. mill at the Briar Hill Steel Co., is driven by a 2,500-hp., 2,200-volt induction motor running at 240 r.p.m. It is coupled to the mill through a single reduction gearing in the pinion housing, which gives the rolls a speed of 50 r.p.m. This unit carries a 31-ton flywheel mounted between the motor and the pinion bearing. Two stands are used in tandem, the roughing stand reversing and the finishing stand three-high continuous..

The 132-in. plate mill is a three-high unit and is driven by a 5,000-hp. motor having the same general features as the one that drives the finishing stand of the 84-in. mill. It runs at 197 r.p.m. and is connected to the mill through reduction gears in the pinion housing, which gives the rolls a speed of 45 r.p.m. The flywheel weighs 60 tons, and a liquid slip regulator limits the peaks on the motor. This mill rolls a slab having an average weight of 2,670 lb., an average thickness of 7 in. and 28 in. wide; the average size of the finished plate is $\frac{7}{16}$ in. thick and 72 in. wide.

It will be interesting to note that the power consumption of the entire 84-in. mill during one run of 12 hours was 52.3 kw.-hr. per long ton, and that the power consumption on the main drive was 4,850 kw.-hr. and 9,950 kw.-hr. on the main motor of the three-high finishing mill. On the new 132-in. plate mill the figures available show that the consumption was 43.6 kw.-hr. per ton; the power consumption of the main motors was 31.5 kw.-hr., and the power consumption per ton of the auxiliaries was in this instance 12.1 kilowatt-hours.

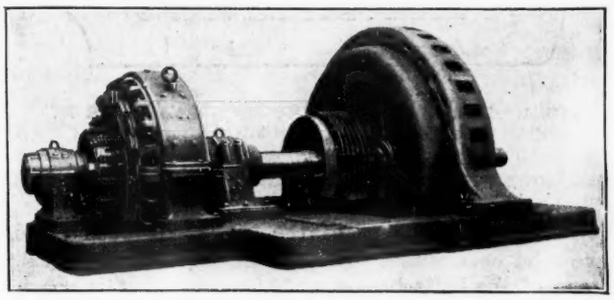


FIG. 9. A 1,500-HP ADJUSTABLE-SPEED ALTERNATING-CURRENT MOTOR

(Large reversing mill motors will be taken up in the next article.)

Steam-Engine Operation and Maintenance—Knocks Due to Connecting Rods and Pistons

By H. HAMKENS
Consulting Engineer, Newton, New Jersey

THE connecting-rod brasses are subject to more or less trouble. There is first of all the wear in the bore; this is taken up by adjustment, as far as it will go. It will happen that the wear on one half of the boxes is much greater than on the other, in which case one or more liners may be inserted behind each box, as shown in Fig. 1. As the brasses wear, the distance between centers should be checked and readjusted; if both wedges are on the inside, shims are again resorted to. There is also a possibility of the brasses showing some wear on one or the other of the faces, which is generally due to the engine being out of line; this may cause a disagreeable pound. It can be remedied by soldering a thin washer of copper or brass on the face of the box, as shown in Fig. 2. A pair of spare brasses for each end of the rod help if there is trouble with the old ones. Trouble with the adjusting bolts is always a probability. With the increase in engine speeds this trouble has multiplied; it seems to be due to vibration caused by the fore and back movements of the wedges, which expose the bolts to bending strains; they break under the heads, which is naturally the weakest spot for steel on account of the large reduction in diameter. These bolts should never be made from machine steel and should not be cut from a solid bar; they should be forged of the best quality of wrought iron having a good fiber and great difficulty, like Norway or Swedish iron. A simple test of the quality of the material would be to clamp one of the bolts in a vise and hit the head several

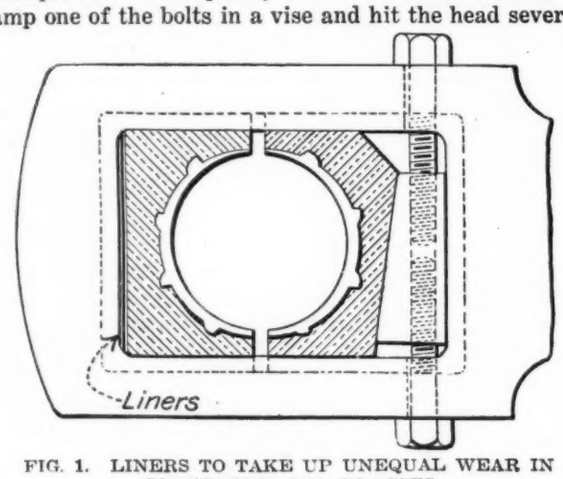


FIG. 1. LINERS TO TAKE UP UNEQUAL WEAR IN CONNECTING-ROD BRASSES

hard blows with a hammer in different directions. This will show whether the head can be broken off or not.

Probably 90 per cent of the connecting rods made have solid ends, similar to the design shown in Fig. 3. If one of the bolts breaks under the head, it is sometimes quite a job to remove the wedge, especially if the bolt fits tight. Since brasses and wedge have to come out together in this construction, the wedge bolts must be first removed. Sometimes there is a chance to get hold of the broken bolt with a pipe wrench, but if not or if the bolt cannot be backed out with a chisel, a hole must be drilled into it so that it can be screwed out by using a reamer. Some engineers prefer one long bolt (shown at *B* in Fig. 3) to the two short ones; it is less likely to break, and if it does there is a better chance to back it out. The disadvantage is that the wedge cannot be locked.

The crosshead end of the connecting rod is mostly rounded to conform with the cavity in the crosshead, as

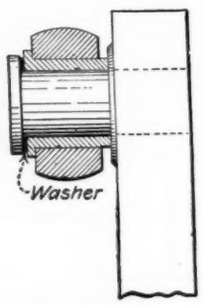


FIG. 2. WASHER SOLDERED ON FACE OF BRASSES TO TAKE UP SIDE PLAY

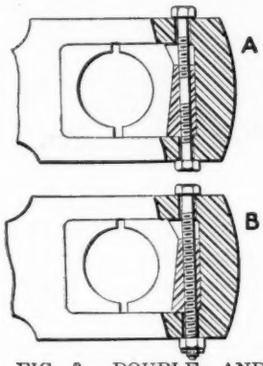


FIG. 3. DOUBLE- AND SINGLE-BOLT WEDGE ADJUSTMENT

shown in Fig. 4. The small half of the brasses is rounded, following the shape of the rod, which is inconvenient for inserting shims. It requires some skill to solder the strips to the brass and fit it again so it will bear all around the cavity.

There are quite a number of places on the piston and rod where a pound may develop. The fastening at the crosshead, of whatever kind it may be, may get loose, a cotter will back out or the rod unscrew, even far enough to let the piston strike the back head. The trouble with the cotter or wedge is sometimes attested by the outer end being mashed by hammer blows in efforts to tighten the rod. Where this has been done, it would be worth while to do a little investigating, there is evidently some trouble that should be corrected. For some reason or other the taper end of the piston rod may have been forced into the crosshead deeper than was originally intended, the insignificant shoulder on the rod not offering sufficient resistance, and the condition may be as represented in Fig. 5. In that case no amount of hammering will permanently tighten the rod. It will tend to break off the end of the rod. The only effective remedy will be a new rod and wedge with plenty of clearance between the shoulder and face of the crosshead.

If the nut on a screwed-in piston rod, as shown in Fig. 6, gets into the habit of backing off, it usually is a sign of the piston rod and crossheads being out of line. The nut can be secured by setting it up tight, but that will only throw the strain on some other part. It will be more advisable to get a new crosshead which is commercially perfect in every respect.

A pound or noise in the cylinder is usually blamed on the piston, and in perhaps nine cases out of ten the suspicion will be found to be correct. A piston composed of a dozen or more parts may certainly become a source of trouble. To reduce the number of parts and

the chances of any of them getting loose, pistons are sometimes made of one piece with a couple of snap rings, as shown in Fig. 7. Since there is no way of taking up wear on horizontal engines, pistons of this kind should be made long. There should be a number of oil grooves cut in the circumference, and lubrication must be well attended to. Generally, pistons of this kind are pressed on the rod and the ends riveted over. On account of the long fit there is not much danger of their getting loose. The conventional Corliss engine piston is shown in Fig. 8; it embodies most of the good features that a piston should have, some of which are lacking in other designs. One of the good points often omitted is the collar on the rod. To reduce expense some engine builders turn down the rod for the fit in the piston spider with a small shoulder that is entirely inadequate.

As a rule pistons are rarely examined. They are left severely alone as long as no trouble develops. Every possible precaution should therefore be taken to prevent them getting out of order. Any nut, bolt or pin used in the construction must be well secured. The follower bolts may become a source of great trouble; if ordinary studs or tapbolts are used, there is always the possibility of one of them getting loose and working out. When it strikes the back head, there is first perceptible a light click, which gradually increases to a pound, indicating that not much time must be lost in

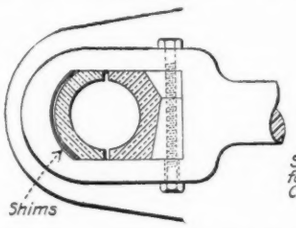


FIG. 4. SHIMS FITTED TO ROUNDED END OF CROSS-HEAD-PIN BRASSES

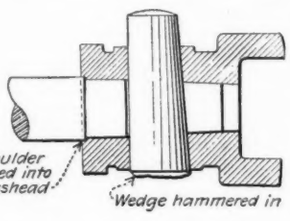


FIG. 5. TAPER END OF PISTON ROD FORCED INTO CROSSHEAD

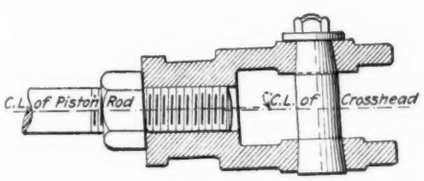


FIG. 6. SHOWING THE PISTON ROD OUT OF LINE WITH CROSSHEAD

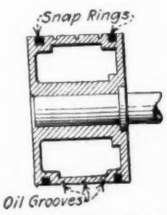


FIG. 7. ONE-PIECE PISTON WITH SNAP RINGS

stopping the engine and remedying the trouble. If the follower bolts are secured as shown in the illustration, and made of high-grade Norway iron, there is little chance of their breaking or working out. The nuts can be easily secured by prickpunching. The question of which is the best kind of a piston ring, split or sectional, has never been definitely decided; for pistons up to 24 in. diameter the split ring, either concentric or eccentric, seems to be favored. It does not require springs, which are always objectionable, and it can be easily replaced and fitted to the piston and cylinder. A horizontal cylinder wears out of round; a new ring should, therefore, be carefully filed to a good all-around fit. The split should be placed down and the ring kept from rotating by a pin. For some apparently unaccountable reason a horizontal cylinder sometimes wears down very rapidly. This may be due to the material of which it is made, probably soft and open iron, unsuitable for the wear it has to stand. The best mixture for cylinders consists of half pig iron and half scrap, first melted and cast into pigs and then remelted again in a cupola. Air-furnace iron cannot be recommended for the purpose; it is generally too open and spongy. On pistons 25 in. in diameter and over it is good practice to face part of the junk ring with some soft metal like red metal; babbitt has been tried, but with little success; it will melt, and in a short while nothing more is left of

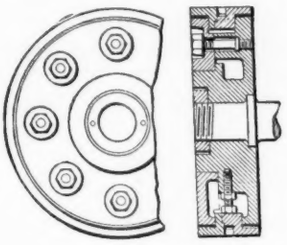


FIG. 8. CONVENTIONAL PISTON FOR A CORLISS ENGINE

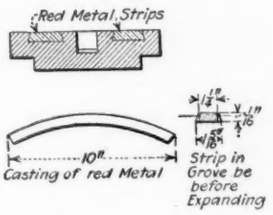


FIG. 9. RED-METAL STRIPS IN JUNK RING

it than a few pieces which are knocked about in the grooves. Red metal is an alloy the composition of which is not recorded in any text or reference books, although it has been used considerably as an antifriction metal for the last twenty years.

The ingredients of a red metal that has been used successfully are 51 per cent copper, 48 per cent lead, ½ per cent tin, ½ per cent nickel with 2 oz. of ferromanganese per 100 lb. as a flux; the copper is melted first, the ferromanganese is added, then lead and tin. The metal must be kept well stirred, otherwise the lead settles to the bottom. The alloy is cast in strips, which are hammered into dovetailed grooves turned into the face of the junk ring, as shown in Fig. 9, and turned flush with the face. They have been let project about 3/32 in. or even 1/16 in. with the idea of supporting the piston solely on the soft metal strips, but this is not feasible since in a short time they wear down to the face of the ring, with the result that the junk ring gets too much play in the cylinder.

Some engineers are of the opinion that a furnace designed for coal fuel can be converted into an oil or gas-burning furnace. This is a false idea. It is possible to either cover the grates with firebrick, leaving air spaces between them and placing burners in the furnace doors, or placing the burners below, say in the ashpit doors, but the result is not always satisfactory. First, the combustion chamber must be designed differently so as not to allow the flames to come in contact with the comparatively cold boiler shell. The bridge wall, its design and height, should receive consideration, as well as the location of the burners. Sometimes it is necessary to place them in the rear of some types of water-tube boilers to get the best results.

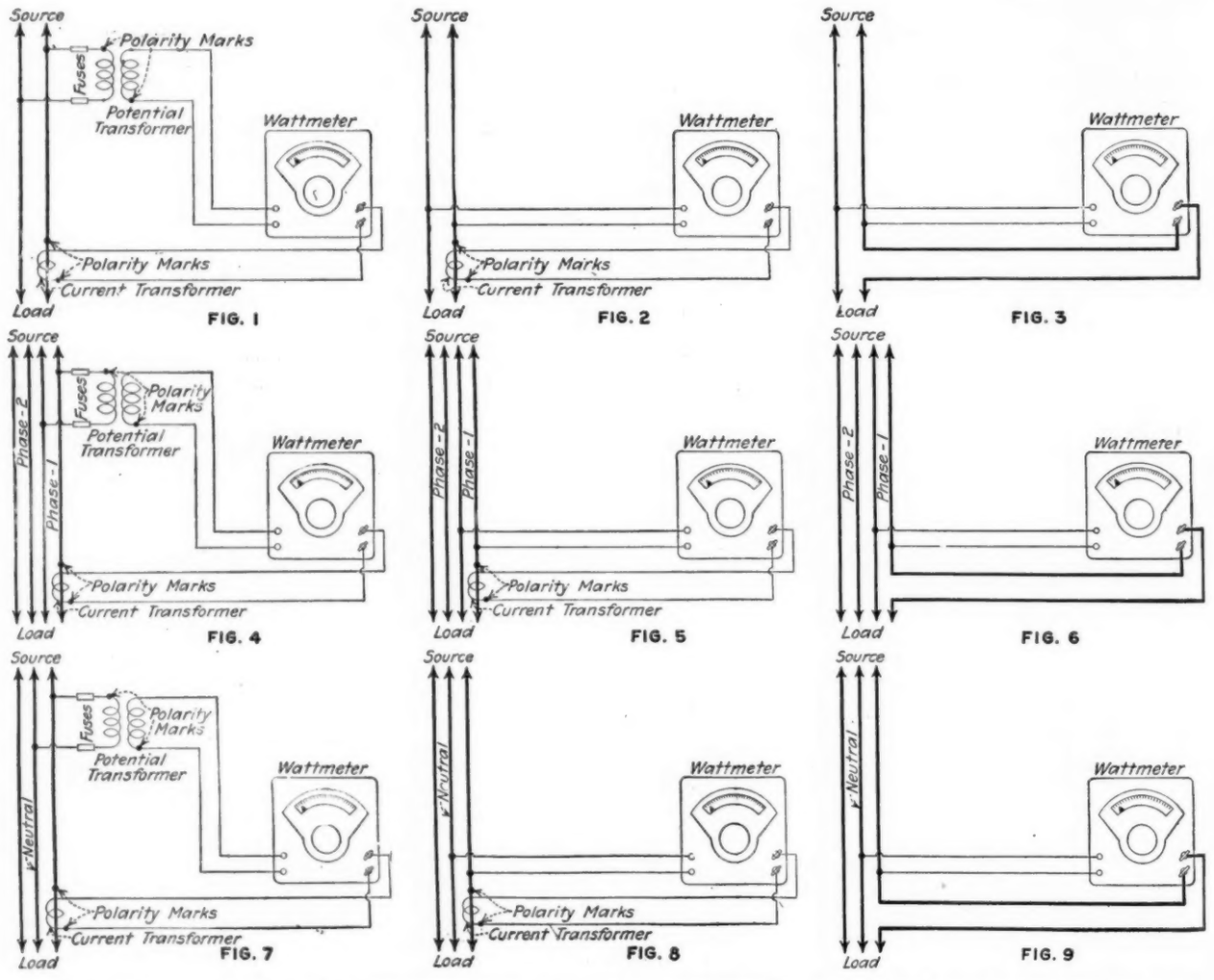
In hand-fired plants, using coal for fuel, do not permit the rate of combustion to fall below fifteen pounds per square foot of grate surface per hour. With stokers the rate of combustion may be as high as the design of the plant will permit. When firing with fine steam-size coal, the rate should not be less than ten pounds per square foot of grate area per hour.

Connections for Measuring Power with Single-Phase Wattmeters

By H. C. YEATON

A SINGLE-PHASE wattmeter may be used to measure not only a single-phase load, but also the power of a balanced four-wire two-phase, a balanced three-wire two-phase, a balanced three-wire three-phase, or a balanced four-wire three-phase circuit. If the polyphase circuits are not balanced or the power factors of all phases of the polyphase circuits are not the same, only the approximate power of the circuits simply necessary to reverse the leads on the potential studs of the instrument to obtain correct polarity.

Modern instrument current and potential transformers have one primary and one secondary terminal marked, which indicates that if the instantaneous current flows into one marked terminal, it flows out of the other marked terminal. This explains the meaning of polarity marks shown in the figures. Fig. 2 gives



FIGS. 1 TO 9. SINGLE-PHASE WATTMETER CONNECTIONS FOR MEASURING POWER IN SINGLE-PHASE AND TWO-PHASE CIRCUITS

can be ascertained, which in some instances might be satisfactory to temporary measurement in case of emergency. The following descriptions and diagrams explain how the foregoing can be attained.

Connection for measuring the power with a single-phase wattmeter in a single-phase circuit is shown in Figs. 1, 2, and 3. If the instrument is used in connection with current and potential transformers, as in Fig. 1, the readings must be multiplied by the ratios of both transformers. In case the pointer tends to move in the wrong direction, indicating wrong polarity, it is the connections of the instrument where only a current transformer is used and Fig. 3 the connections of the instrument when no transformers are used.

The scales of portable wattmeters are almost invariably marked in accordance with their windings and have to be multiplied by transformer ratios when used with transformers. Switchboard wattmeters usually have their scales marked in primary watts and are calibrated for use with transformers with which they are going to be used. This eliminates all calculations, as the wattmeter scale reads direct.

If it is desired to measure the power of a balanced four-wire two-phase circuit with a single-phase wattmeter, connect the instrument as shown in Figs. 4, 5 or 6, according to conditions. Should the pointer indicate incorrect polarity, reverse the leads on the potential studs of the instrument. In Fig. 4 the instrument is connected into the circuit with both potential and current transformers, in Fig. 5 current transformers only are used, and in Fig. 6 the instrument is connected directly into the circuit without transformers. It is obvious from the figures that the instrument measures the power in only one phase of the system, and as there are two phases, the scale readings must be multiplied by 2, and if current and potential transformers are used, the scale readings should be multiplied by the ratios of the transformers also. For example, if the wattmeter indicates 5.4 kw. and the ratio of the potential transformer is 20:1 and that of the current transformer 10:1, then the scale reading of the wattmeter is multiplied by 2, 20 and 10, or the kilowatts in this case are $5.4 \times 2 \times 20 \times 10 = 2{,}160$.

To measure the power of a balanced three-wire two-phase circuit with a single-phase wattmeter, the instrument is connected as shown in Figs. 7, 8 or 9. Like that for the four-wire two-phase circuit the scale readings are multiplied by 2 and also by the ratios of each transformer when used to obtain the power in the circuit.

Power of a balanced three-wire three-phase circuit may be measured with a single-phase wattmeter, by connecting the instrument, as indicated in Figs. 10, 11 and 12, through a "Y" box resistor. The "Y" box resistor consists of two legs, the resistance of each leg being equal to that of the potential circuit of the instrument. To obtain the total power in the circuit, multiply the scale readings of the instrument by 3 and also by the potential and current transformer ratios, provided transformers are used. Like all single-phase wattmeters, the potential connections should be reversed if the instrument indicates incorrect polarity by the needle tending to rotate in the wrong direction. It is essential that a "Y" box be used with the single-phase wattmeter in order that the current passing through the instrument will have the same phase relation as the potential across the instrument. A brief explanation of this follows:

Referring to Fig. 13, the current through the instrument is taken from the phase 0-1, and in order to obtain a corresponding potential an artificial neutral point is obtained by means of a "Y" resistor. The leg *A* which includes the instrument has the same phase relation as the phase 0-1. Therefore, if the current and an equivalent potential of phase 0-1 is measured by the single-phase wattmeter, the scale will read the true watts in the phase; and if the power factor of each phase is the same and the system is balanced, then the wattmeter reading may be multiplied by 3 to obtain the total power in the system.

If the instrument is connected as in Fig. 14, the potential across the instrument is out of phase with the current passing through the instrument by 30 deg., at unity power factor. At other power factors the current and voltage in the three phases have different phase relations. Therefore, it would not be advisable to use this method for measuring the power of three-wire three-phase circuit. However, in this case, if the system is balanced and the power factor is unity, the

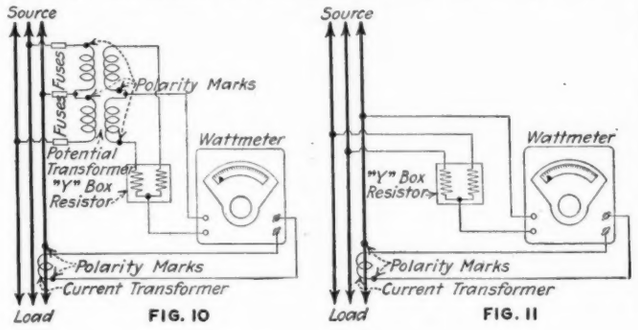


FIG. 10

FIG. 11

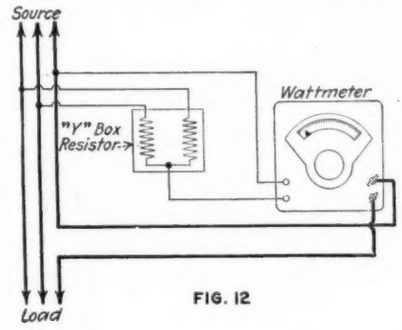


FIG. 12

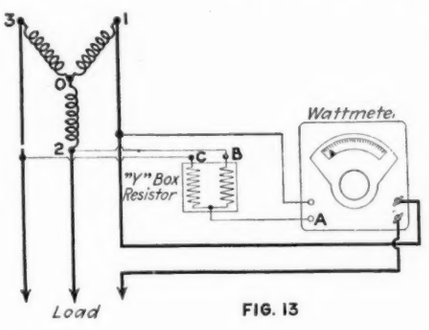


FIG. 13

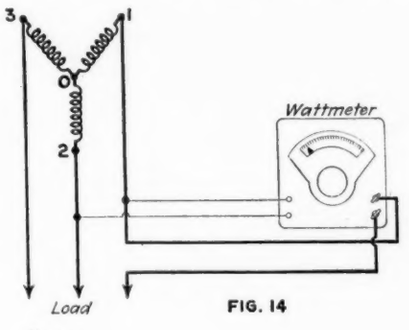


FIG. 14

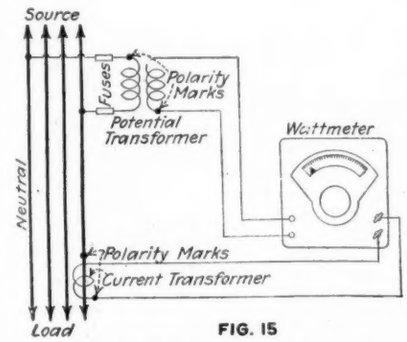


FIG. 15

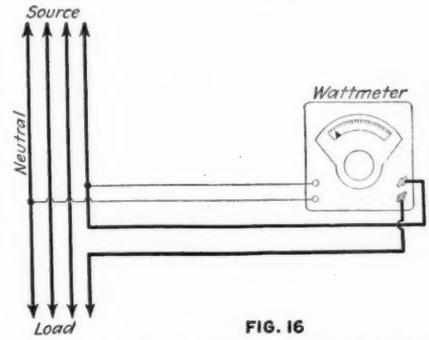


FIG. 16

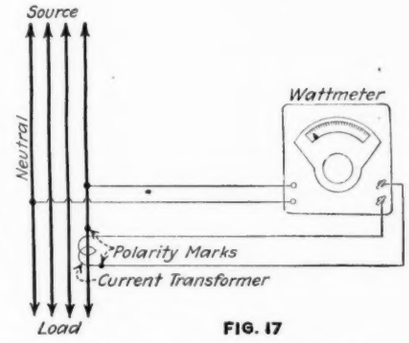


FIG. 17

FIGS. 10 TO 17. SINGLE-PHA' WATTMETER CONNECTIONS FOR MEASURING POWER IN A THREE-WIRE OR FOUR-WIRE THREE-PHASE CIRCUIT

power of the circuit is equal to the wattmeter reading multiplied by 2 (not 3 as when the "Y" resistor is used) and the ratio of the transformer if used.

Balanced four-wire three-phase systems are not quite so common as the foregoing circuits, but if it is desired to obtain the power of such a circuit with a single-phase wattmeter, the connections given in Figs. 15, 16 or 17 are used. The power of the circuit is equal to the scale readings multiplied by 3 and also multiplied by the ratios of the transformers being used.

The Cammellaird-Fullagar Diesel Engine

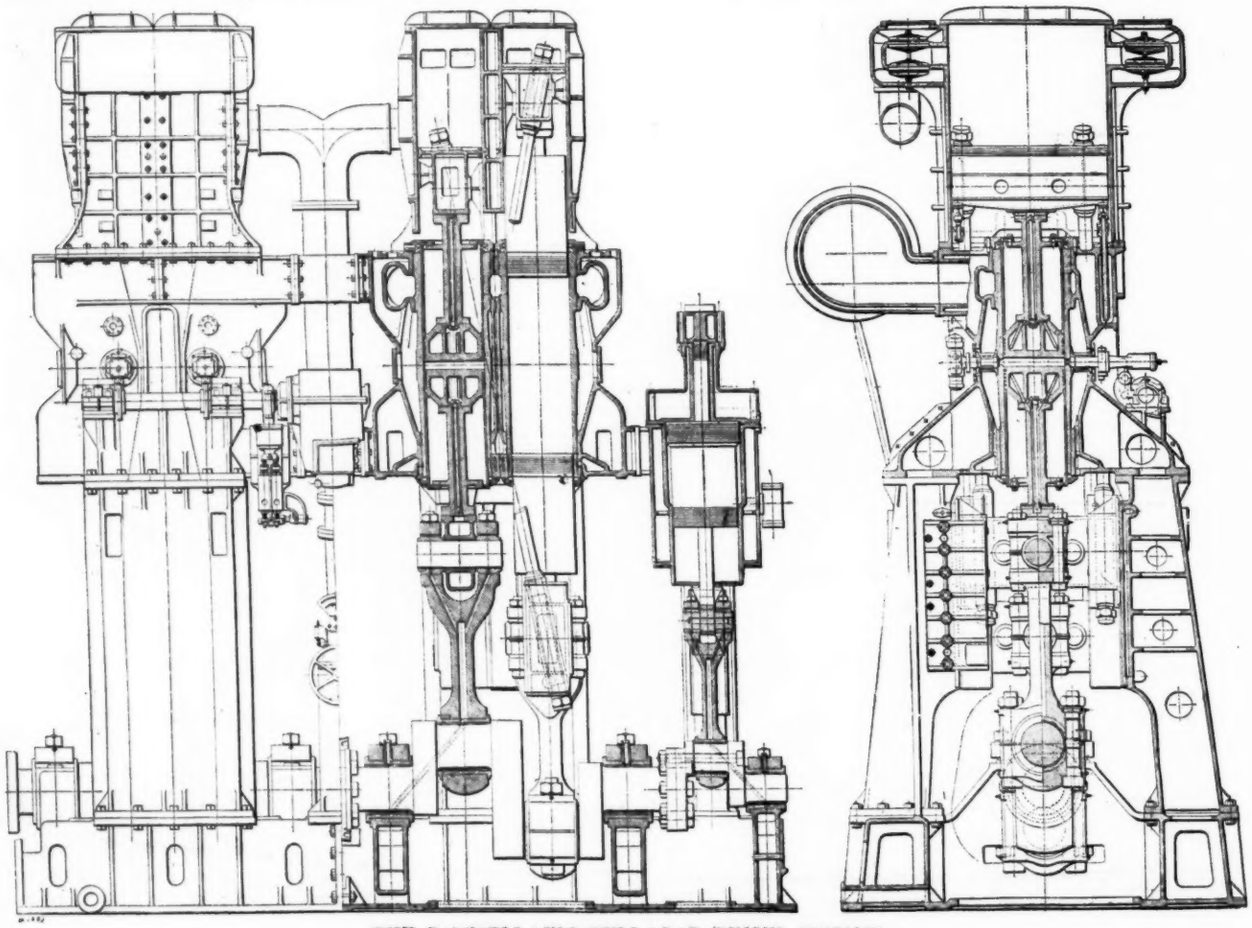
Recently, a 500-ton coasting motorship was launched at Birkenhead, England. One unusual feature was the welding of all plate seams, riveting being entirely absent. The vessel is of interest since it is fitted with two Cammellaird-Fullagar high-compression oil engines.

The Fullager engine is of the two-cycle opposed piston type. The engine is made up of two units, each unit consisting of two cylinders. In each cylinder are two pistons, moving inward together on the compression stroke, the combustion chamber being formed between the tops of the two pistons. The fuel is injected into this central space. As the pistons move outward under the influence of the burning charge, the upper piston uncovers a series of ports which allow the gases to escape. At the same time the lower piston uncovers the scavenging ports. The air then completely clears the cylinder of the burnt charge.

The engine differs from the usual opposed-piston engine by having the upper and power pistons of adjacent cylinders linked together by diagonal tension rods. This design eliminates the cranks that would otherwise be required for the upper pistons. The engine is, as a consequence, considerably shorter, fore and aft, than either a two-cycle or four-cycle engine of equal capacity. The diagonal rods are always in tension, relieving the crank of all pressure on the compression stroke. This feature should reduce the lubrication difficulties experienced with many two-cycle engines. The upper pistons have rods and crossheads with which to resist the side pressure of the diagonal rods. The crossheads are inclosed, and the cavities thus formed act as the scavenging cylinders. The scavenging piston is rectangular in form, but it is claimed that the leakage at the corners is negligible.—*Gas and Oil Power.*

In designing a boiler furnace for burning oil or gas, whether of the vertical or horizontal return-tubular type, careful consideration should be given to the combustion chamber, bridge wall, additional checker wall to separate the flames of the burners, the draft, whether natural or forced, location of burners, water- or fire-tube boilers, the transportation of fuel and tight settings.

Poor firing causes holes to develop in the fuel bed. Carrying an uneven fire, too thin or too heavy a fire, shaking the grates or using the slice bar too frequently (which causes clinkers) and improper care of dampers reduce the boiler efficiency. Attention to what the boiler is doing from day to day will pay good returns, if faulty conditions are remedied when first detected.



THE CAMMELLAIRD-FULLAGAR DIESEL ENGINE

Government Standards for Oils and Greases

Here follows an abstract of the report of the United States Government's Committee on Standardization of Lubricants. Under these standards of test methods and qualities, lubricants for the Government will be purchased. All the test methods here given may readily be applied in the usual power plant by the engineers in charge.

Methods of Testing Lubricants

FLASH POINT—This test shall be made in the Cleveland open-cup tester, the apparatus being used without any bath or outer cup surrounding the oil cup. The oil cup should have two marks on the inside, the first ¼ in. below the top, and the second ⅜ in. below, the first to be used when testing oils with a flash point below 425 deg. F. and the second when testing oils with a flash point at or above 425 deg. F. The clean oil cup should be inserted into the tripod ring, which must be level, and the cup filled to the proper mark with the oil to be tested. Care should be exercised not to spill any oil on the sides or top of the cup, and if this accident should happen, all such oil must be carefully removed. A "bulb immersion" thermometer should then be inserted into the oil and suspended from a suitable support. The bulb of the thermometer should be ⅜ to ⅝ in. in length. During the test the bulb must be fully covered by the oil and the bottom of the thermometer must not be less than ¼ in. from the bottom of the cup. The thermometer must be suspended in the oil midway between the center and inside edge of the cup. The alcohol or gas burner is then placed under the oil cup so as to heat it uniformly. The oil may be heated rapidly at first, but the rate of heating should be 8 to 10 deg. F. per minute during the last 80 deg. of heating prior to attaining the flash point. As the flash point is approached, a test is made for every 5 deg. F. rise in temperature (on the readings which are multiples of 5) by slowly passing a small bead-like test flame, not exceeding ⅛ in. in length, across the center of the cup ¼ in. above the surface of the oil, the movement occupying one second.

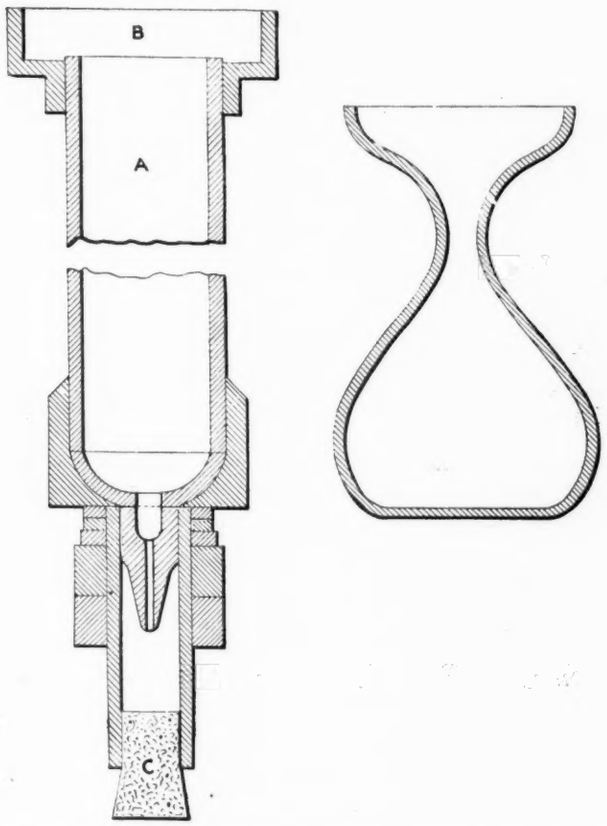
The temperature when a flame first jumps from the test flame to the oil is called the flash point of the oil. The test must be made where the cup is free from drafts and must also be made in a subdued light.

Fire Point—After the flash point has been obtained, the same method of testing shall be continued until the oil takes fire and continues to burn. The temperature at which the oil continues to burn is the fire point of the oil.

Viscosity (A. S. T. M. method. Revised in 1920.)—1. Viscosity shall be determined by means of the Saybolt standard universal viscosimeter.

2. The Saybolt standard universal viscosimeter (see section) is made entirely of metal. The standard oil tube *A* is fitted at the top with an overflow cup *B*, and the tube is surrounded by a bath. At the bottom of the standard oil tube is a small outlet tube through which the oil to be tested flows into a receiving flask, (right) whose capacity to a mark on its neck is 60 (±0.15) c.c. The lower end of the outlet tube is inclosed by a larger tube, which when stoppered by a cork *C*, acts as a closed air chamber and prevents the flow of oil through the outlet tube until the cork is removed and the test started. A looped string may be attached to the lower end of the cork as an aid to its rapid removal. The temperatures in the standard oil tube and in the bath are shown by thermometers. The bath may be heated by any suitable means, The standard oil tube shall be thoroughly cleaned, and all oil entering the standard oil tube shall be strained through a 60-mesh wire strainer. A stop watch shall be used for taking the time of flow of the oil, and a pipette shall be used for draining the overflow cup of the standard oil tube.

The standard oil tube, which may be standardized by



SECTION OF OIL TUBE USED WITH SAYBOLT STANDARD VISCOSIMETER; RECEIVING CUP IS SHOWN TO THE RIGHT

the United States Bureau of Standards, Washington, D. C., shall conform to the following dimensions:

Dimensions	Minimum, Cm.	Normal Cm.	Maximum Cm.
Inside diameter of outlet tube	0.1750	0.1765	0.1780
Length of outlet tube	1.215	1.225	1.235
Height of overflow rim above bottom of outlet tube	12.40	12.50	12.60
Diameter of container of standard oil tube	2.955	2.975	2.995
Outer diameter of outlet tube at lower end	0.28	0.30	0.32

3 Viscosity shall be determined at 100 deg. F. (37.8 deg. C.), 130 deg. F. (54.4 deg. C.) or 210 deg. F. (98.9 deg. C.). The bath shall be held constant within 0.25 deg. F. (0.14 deg. C.) at such a temperature as will maintain the desired temperature in the standard oil tube. For viscosity determinations at 100 deg. and 130 deg. F., oil or water may be used as the bath liquid.

For viscosity determinations at 210 deg. F., oil shall be used as the bath liquid. Viscosity determinations shall be made in a room free from drafts and from rapid changes in temperature. All oil introduced into the standard oil tube, either for cleaning or for test, shall first be passed through the strainer.

To make the test, heat the oil to the necessary temperature and clean out the standard oil tube. Pour some of the oil to be tested through the cleaned tube. Insert the cork stopper into the lower end of the air chamber at the bottom of the standard oil tube, sufficiently to prevent the escape of air, but not to touch the small outlet tube of the standard oil tube.

Heat the oil to be tested, outside the viscosimeter, to slightly below the temperature at which the viscosity is to be determined and pour it into the standard oil tube until it ceases to overflow into the overflow cup. By means of the oil-tube thermometer keep the oil in the standard oil tube well stirred and also stir well the oil in the bath. It is extremely important that the temperature of the bath be maintained constant during the entire time consumed in making the test. When the temperature of the bath and of the oil in the standard oil tube are constant and the oil in the standard oil tube is at the desired temperature, withdraw the oil-tube thermometer; quickly remove the surplus oil from the overflow cup by means of a pipette so that the level of oil in the overflow cup is below the level of the oil in the tube proper; place the 60-c.c. flask in such a position that the stream of oil from the outlet tube will strike the neck of the flask so as to avoid foam. Snap the cork from its position, and at the same instant start the stop watch. Stir the liquid in the bath during the run and carefully maintain it at the previously determined proper temperature. Stop the watch when the bottom of the meniscus of the oil reaches the mark on the neck of the receiving flask.

The time in seconds for the delivery of 60 c.c. of oil is the Saybolt viscosity of the oil at the temperature at which the test was made.

Pour Test (A. S. T. M. Method D47-18)—1. The pour test indicates the temperature at which a sample of oil in a cylindrical container of specified diameter and length will just flow under specified conditions.

Apparatus For Pour Test

2. Apparatus: The apparatus for the pour test consists of the following: glass jar, approximately 1¼ in. inside diameter and 4 to 5 in. high, provided with a tightly fitting cork; mercury thermometer, fitted securely in the cork so that the shaft will be held centrally in the jar with the tip of the bulb ½ in. from the bottom (the thermometer specially made for this test has a bulb ¼ to ⅜ in. long); metal jacket, closely fitted around the glass jar and provided at the bottom with a disk of cork felt about ¼ in. thick.

3. Method: Place the oil in the jar to a depth of about 1¼ in., or to a sufficient depth to reach ¼ in. above the bulb of the thermometer; fit the cork tightly into the jar and place the jar in the metal jacket; then place the jacket in a freezing mixture. At each drop in temperature of 5 deg. F. (on the readings which are multiples of 5 deg.) remove the jar from the jacket and tilt it just enough to make the oil flow. The pour test of the oil shall be taken as 5 deg. higher than the reading of the thermometer when the oil has cooled so that it will not flow when the jar is tipped to a horizontal position.

4. The rate of cooling should be such that the pour test be completed in about one-half hour.

5. The materials used in the freezing mixture vary with the temperature required to cause the lubricant to solidify. Cracked ice will be sufficient for a temperature above plus 35 deg. F. For temperatures between plus 15 deg. F. and plus 35 deg. F. a mixture consisting of one volume of salt and twenty volumes of ice may be used. The salt for this purpose should be dry and fine enough to pass a 20-mesh screen. From plus 15 deg. to minus 5 deg. F. ice and salt in the proportions of one to two are suitable. From 0 deg. to —25 deg. F. a mixture of ice and calcium chloride is used. For temperatures lower than —5 deg. F. a mixture of solid carbon dioxide and acetone is more convenient and will produce temperatures of —70 deg. F. or less.

6. To obtain the solid carbon dioxide, invert an ordinary liquefied carbon-dioxide cylinder, open the valve carefully and let the gas flow into a chamois-skin bag. Rapid evaporation will cause the carbon dioxide to solidify.

7. The carbon dioxide-acetone mixture may be made as follows: Place a sufficient amount of dry acetone in a covered copper or nickel beaker; place the beaker in an ice-salt mixture and when the acetone reaches plus 10 deg. F. or less, add solid carbon dioxide gradually until the desired temperature is reached.

Cold Test for Cylinder Oils

Cold Test of Steam Cylinder and Black Oils (A. S. T. M. Method D47-18)—The object of the cold test is to determine the lowest temperature at which oil will flow from one end of a container to the other, in case it should become frozen and the resulting solid oil stirred till it has assumed a sufficiently pasty consistency to flow. The test is conducted by freezing an ounce of the oil solid in an ordinary 4-oz. sample bottle, using a freezing mixture if necessary. A thermometer should then be introduced into the frozen mass, and after it has become cold, the bottle containing the congealed oil is removed from the cooling medium. The frozen oil is thoroughly stirred with a thermometer until the mass will run from one end of the bottle to the other, and at this moment the temperature as indicated is recorded. The reading is the cold test of the oil.

If the figures indicating the cold test are inside the bottle and covered by the softened oil, the reading can be obtained by grasping the bottle by the neck with one hand, having in the same hand a piece of waste, which incloses the thermometer. The thermometer is then withdrawn through the waste with the other hand for a sufficient distance to enable the operator to see the end of the mercury column and read the temperature.

Saponification—Weigh 10 grams of oil into a 350-c.c. Erlenmeyer flask. Add from a pipette 50 c.c. of the alcoholic potassium hydroxide solution followed by 25 c.c. of the purified benzene (C_6H_6). Connect with a condenser loop. Boil on steam bath or electric hot plate for 90 min., shaking occasionally. Remove and add 25 c.c. of neutral gasoline, and titrate with the half normal hydrochloric-acid solution, after adding 2 or 3 drops of the phenolphthalein indicator solution until the pink color is destroyed. The absence of the pink color may be determined after the titration has begun, by allowing the solution to stand at rest approximately a minute and noting the color of the lower zone. Run two blanks with the same mixture of alcoholic potassium

hydroxide solution and purified benzene. From the difference between the number of cubic centimeters of half-normal acid required for the blanks and for the determination, the percentage of fatty oil may be calculated as follows:

$$\left[\frac{\text{No. of c.c. } N/2 \text{ acid used} \times .02805 \times 100}{0.195 \times \text{weight of oil taken}} = \text{per cent of fatty oil}\right].$$

Corrosion—A clean strip of pure copper about $\frac{1}{2}$ in. wide and 2 in. long is heated to redness in a bunsen flame and while red hot dropped into alcohol. The strip is then allowed to dry as quickly as possible in the air and dropped into a sample of the oil contained in a test tube. About half the length of the copper strip should be submerged. The test tube is then closed with a stopper and left to stand for 24 hours. At the end of this time the copper strip is removed and washed clean with proper solvents. It is then compared with a similar strip freshly cleaned as previously described. No discoloration of the test strip should be shown by this comparison.

Evaporation—Twenty grams of the oil is placed in a weighted flat-bottomed glass crystallizing dish having a diameter of approximately $3\frac{3}{4}$ in. The dish is then placed in an oven at a temperature of 212 deg. F. for two hours, cooled in a desiccator, and weighed.

Precipitation—Five c.c. of the oil is mixed with 95 c.c. of petroleum ether in a tall stoppered graduated cylinder and allowed to stand. The petroleum ether must be freshly redistilled and the portion boiling above 150 deg. F. discarded. It must not show perceptible solubility in concentrated sulphuric acid.

Protection—A clean polished steel plate 2 in. long, $\frac{1}{2}$ in. wide, and $\frac{1}{8}$ in. thick, is coated by immersing in the lubricant which has been heated to a temperature of 212 deg. F. The plate is removed while still hot, allowed to cool in a vertical position and suspended vertically within a 10 per cent salt solution.

Specifications for Lubricating Oils, Class A

1. This specification covers the grades of petroleum oil used by the United States Government and its agencies for the general lubrication of engines and machinery where a highly refined oil is not required. This oil is not to be used for steam-cylinder lubrication.
2. Only refined petroleum oils without the admixture of fatty oils, resins, soap, or other compounds not derived from crude petroleum, will be considered.
3. These oils shall be supplied in five grades, known as extra light, light, medium, heavy and extra heavy.

Properties and Tests:

4. Flash and Fire Points: The flash and fire points of the five grades shall not be lower than the following:

	Flash, Deg. F.	Fire, Deg. F.
Extra light	315	355
Light	325	365
Medium	335	380
Heavy	345	390
Extra Heavy	355	400

5. Viscosity: The viscosity of the five grades of oil at 100 deg. F. must be within the following limits:

	Seconds
Extra light	140–160
Light	175–210
Medium	275–310
Heavy	370–410
Extra heavy	470–520

6. Color: The color of the extra-heavy grade shall not be darker than No. 6 National Petroleum Association standard or its equivalent. The color of the other grades shall not be darker than No. 5 National Petroleum Association standard or its equivalent.

7. Pour Test: The pour test shall not be above the following temperatures:

	Deg. F.
Extra light	35
Light	35
Medium	40
Heavy	45
Extra heavy	50

8. Acidity: Not more than 0.10 milligrams of potassium hydroxide shall be required to neutralize 1 gram of the oil.
9. Corrosion: A clean copper plate must not be discolored when submerged in the oil for 24 hours at room temperature.
10. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

Specifications for Lubricating Oils, Class B

1. This specification covers the grades of petroleum oil used by the United States Government and its agencies for the lubrication of turbines, dynamos, high-speed engines and other classes of machinery where an oil better than Class A is required. The oil must be satisfactory for use in circulating and forced-feed systems.
2. Only refined petroleum oils without the admixture of fatty oils, resins, soaps or other compounds not derived from crude petroleum will be considered.
3. These oils shall be supplied in five grades, known as extra light, light, medium, heavy and extra heavy.

Properties and Tests:

4. Flash and Fire Points: The flash and fire points of the five grades, shall not be lower than the following:

	Flash, Deg. F.	Fire, Deg. F.
Extra light	315	355
Light	325	365
Medium	335	380
Heavy	345	390
Extra heavy	355	400

5. Viscosity: The viscosity of the five grades at 100 deg. F. must be within the following limits:

	Seconds
Extra light	140–160
Light	175–210
Medium	275–310
Heavy	370–410
Extra heavy	470–520

6. Color: The color of the extra-heavy grade shall not be darker than No. 6 National Petroleum Association standard or its equivalent. The color of the other grades shall not be darker than No. 5 National Petroleum Association standard or its equivalent.

7. Pour Test: The pour test shall not be above the following temperatures:

	Deg. F.
Extra light	35
Light	35
Medium	40
Heavy	45
Extra heavy	50

8. Acidity: Not more than 0.07 milligrams of potassium hydroxide shall be required to neutralize 1 gram of oil.
9. Corrosion: A clean copper plate must not be discolored when submerged in the oil for 24 hours at room temperature.
10. Emulsifying Properties: The oil shall separate completely in 30 minutes from an emulsion with: (1) Distilled water; (2) 1 per cent salt solution; (3) Normal caustic soda solution. The demulsibility shall not be less than 300.
11. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

Specifications for Lubricating Oils, Class C

1. This specification covers the grades of petroleum oil used by the United States Government and its agencies for lubrication of air compressors and internal-combustion engines, except aircraft, motor-cycle and Diesel engines; also for the lubrication of turbines and other machinery where an oil better than Class B is required. This oil must be satisfactory for use in circulating and forced-feed systems.
2. Only refined petroleum oils without the admixture of fatty oils, resins, soaps, or other compounds not derived from crude petroleum, will be considered.
3. These oils shall be supplied in five grades, known as extra light, light, medium, heavy and extra heavy.

Properties and Tests:

4. Flash and Fire Points: The flash and fire points of the five grades shall not be lower than the following:

	Flash, Deg. F.	Fire, Deg. F.
Extra light	315	355
Light	325	365
Medium	335	380
Heavy	345	390
Extra heavy	355	400

Oil for use in air compressors where the air leaving any stage or cylinder has a temperature above 212 deg. F. shall have a flash point not lower than 400 deg. F.

5. Viscosity: The viscosity of the five grades at 100 deg. F. must be within the following limits:

	Seconds
Extra light	140–160
Light	175–210
Medium	275–310
Heavy	370–410
Extra heavy	470–520

6. Color: The color of the extra-heavy grade shall not be darker than No. 6 National Petroleum Association standard or its equivalent. The color of the other grades shall not be darker than No. 5 National Petroleum Association standard or its equivalent.

7. Pour Test: The pour test shall not be above the following temperatures:

	Deg. F.
Extra light	35
Light	35
Medium	40
Heavy	45
Extra heavy	50

8. Acidity: Not more than 0.05 milligrams of potassium hydroxide shall be required to neutralize 1 gram of the oil.

9. Corrosion: A clean copper plate must not be discolored when submerged in the oil for 24 hours at room temperature.

10. Emulsifying Properties: The oil shall separate completely in 30 minutes from an emulsion with: (1) Distilled water; (2) 1 per cent salt solution; (3) normal caustic-soda solution. The demulsibility shall not be less than 300.

11. Carbon Residue: The carbon residue shall not exceed the following:

	Per Cent
Extra light	0.10
Light	0.20
Medium	0.30
Heavy	0.40
Extra heavy	0.60

12. Further tests on oils of Class C may be required at the option of the department of the Government using the oils.

13. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

Mineral Steam Cylinder Oil for Non-Condensing Engines

1. This specification covers the grade of petroleum oil used by the United States Government and its agencies for non-condensing steam-engine cylinder lubrication where a mineral oil is required; also as a stock oil for compounding.

Properties and Tests:

2. The oil must be a well-refined petroleum oil without compounding of any nature.

3. Flash Point: The flash point must not be less than 475 deg. F.

4. Viscosity: The viscosity at 210 deg. F. must be within the following limits: 135 to 165 sec.

5. Cold Test: The cold test must not be above 45 deg. F.

6. Precipitation Test: When 5 c.c. of the oil is mixed with 95 c.c of petroleum ether and allowed to stand 24 hours, it shall not show a precipitate or sediment of more than 0.25 c.c. (5 per cent by volume of the original oil).

7. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

Compound Steam Cylinder Oil for Non-Condensing Engines

1. This specification covers the grade of petroleum oil used by the United States Government and its agencies for the lubrication of steam cylinders of non-condensing engines and pumps where a compounded oil is required.

Properties and Tests:

2. The oil must be a well-refined petroleum oil, compounded with not less than 5 nor more than 7 per cent of acidless tallow oil or lard oil.

3. Flash Point: The flash point must not be less than 475 deg. F.

4. Viscosity: The viscosity at 210 deg. F. must be within the following limits: 120 to 150 sec.

5. Cold Test: The cold test must not be above 45 deg. F.

6. Precipitation Test: When 5 c.c. of the oil is mixed with 95 c.c of petroleum ether and allowed to stand 24 hours, it shall not show a precipitate or sediment of more than 0.25 c.c. (5 per cent by volume of the original oil).

7. Acidity: The oil must not contain more than 0.40 per cent of acid calculated as oleic acid (equivalent to 0.80 mg. K.O.H. per gram of oil).

8. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

Gear Chain and Wire-Rope Lubricant

1. This specification covers the grade of petroleum oil used by the United States Government and its agencies for the lubrication and protection of chains, wire ropes and gears of cranes, dredges, steam shovels and all other heavy equipment, for the lubrication and protection of the gears and ropes of balloon hoists; and for swabbing the wires and cables of aircraft.

2. The oil must be a petroleum product only, free from vegetable or animal oils or products derived from them. It must be entirely free from fillers, such as talc, resin and all materials of every nature not related to the original product.

Properties and Tests:

3. Viscosity: The viscosity at 210 deg. F. must be within the following limits: 900 to 1,100 sec.

4. Protection: When applied to a plate of polished steel the lubricant must protect the steel for a period of thirty days when immersed in a 10 per cent salt solution.

5. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

Cup Grease

1. This specification covers the grades of cup grease used by the United States Government and its agencies for the lubrication of such parts of motor equipment and other machinery as are lubricated by means of compression cups; No. ½ and No. 1 to be used in spindle cups or transmissions.

2. The grease must be a well manufactured product, composed of a calcium soap and a highly refined mineral oil.

Properties and Tests:

3. The mineral oil used in reducing the soaps must be a straight well-refined mineral oil with a viscosity at 100 deg. F. of not less than 100 sec.

4. Soap Base: This base to be a whole fat such as pure tallow oil, neatsfoot oil, lard oil, horse oil or other pure animal oils used singly or in combination.

(a) No. ½ cup grease shall contain approximately 13 per cent of a calcium soap made from an approved fat.

(b) No. 1 cup grease shall contain approximately 14 per cent of a calcium soap made from an approved fat.

(c) No. 3 cup grease shall contain approximately 18 per cent of a calcium soap made from an approved fat.

(d) No. 5 cup grease shall contain approximately 24 per cent of a calcium soap made from an approved fat.

5. Consistency : These greases must be similar in consistency to the approved trade standards for No. ½, No. 1, No. 3 and No. 5 grease.

6. Moisture: The grease must be a boiled grease, containing not less than one or more than three per cent of water when finished.

7. Corrosion: A clean copper plate must not be discolored when submerged in the grease for 24 hours at room temperature.

8. Ash:

No. ½ grease. The ash shall not be greater than 1.7 per cent
No. 1 grease. The ash shall not be greater than 1.8 per cent
No. 3 grease. The ash shall not be greater than 2.3 per cent
No. 5 grease. The ash shall not be greater than 3.5 per cent

9. Fillers: The grease shall contain no fillers such as resin, resinous oils, soapstone, wax, talc, powdered mica or graphite, sulphur, clay, asbestos, or any other filler.

10. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

Ice-Machine Oil

1. This specification covers the grades of petroleum oil used by the United States Government and its agencies for cleaning and oiling guns and small arms where aircraft machine-gun oil is not required; also for lubrication of cylinders of ice machines; for lubrication of pneumatic tools and for hydraulic systems.

2. The oil must be a straight-run, highly refined petroleum oil, free from vegetable or animal oils or products derived from them; must be suitable in every way for the uses listed in Par. 1; and must not gum or corrode metals under any conditions.

3. These oils shall be supplied in two grades known as No. 100 and No. 125.

Properties and Tests:

4. Flash Point: The flash point must not be less than 300 deg. F.

5. Viscosity: The viscosity at 100 deg. F. must be within the following limits: No. 100 oil, 95 to 110 sec.; No. 125 oil, 120 to 135 sec.

6. Pour Test: The pour test shall not be higher than 5 deg. above zero F.

7. Acidity: Not more than 0.03 milligrams of potassium hydroxide shall be required to neutralize 1 gram of oil.

8. Emulsifying Properties: The oil shall separate completely in 30 minutes from an emulsion with: (1) Distilled water; (2) 1 per cent salt solution; (3) normal caustic-soda solution. The demulsibility shall not be less than 300.

9. All tests shall be made according to the methods adopted by the Committee on Standardization of Petroleum Specifications.

Diesel Engineers

In a recent article on an installation of two 200-hp. Diesel engines mention was made of the troubles occurring during a six months' period of operation. The damages consisted of a fractured crankshaft, two fractured cylinder heads, two damaged piston heads and a fractured cylinder liner. The trouble, apparently, was due to the cooling water. It might have been impossible to install a water-purifying system, but there is no excuse for the failure to keep jackets free from scale by a frequent dose of muriatic-acid solution.

The list of breakages might well be considered an indictment of the operating force. In fact, the trouble is deeper seated. The claim that any ordinary man can operate a Diesel engine has been sponsored too frequently by the manufacturer. It is time to realize that an oil engine requires a man of more than ordinary mechanical skill and one who is possessed with a fund of patience and willingness to work. In the sale of an oil engine the manufacturer should arrange to furnish an erector who would not only erect the engine, but would also remain for a period of nine months to a year to operate the plant and to instruct the plant engineer. In the plant cited, the pay of an erector would not have been one-half the repair bill. The economy of the Diesel is amply attractive, and there is no necessity of employing or advocating the employment of other than high-grade engineers.

Explosion of Blowoff Tank

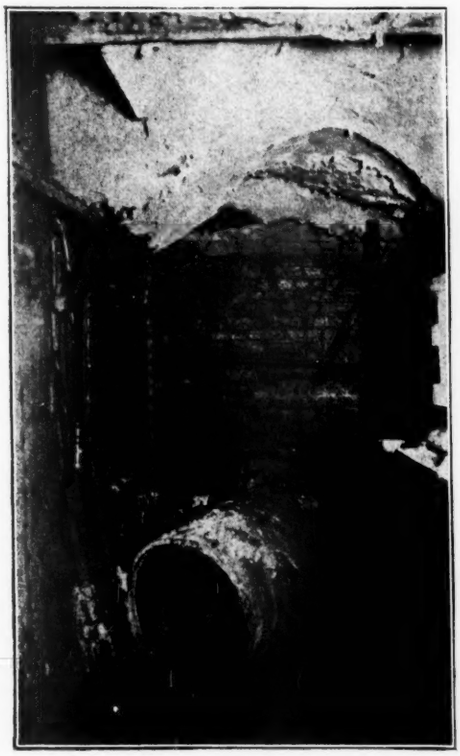
BY GEORGE B. LONGSTREET

On Monday morning, June 15, a cast-iron blowoff tank in the steam plant of Riverbank Court, Cambridge, Mass., exploded. Fortunately, no one was seriously injured. The tank was 26 in. in diameter and 4 ft. high, with flanged heads, top and bottom. It was situated in one corner of the boiler room behind No. 1 boiler and directly beneath the smoke flue.

The rupture occurred in the barrel of the tank close to the bottom flange. At the point of rupture the shell was corroded from its original thickness of $\frac{3}{4}$ in. to $\frac{3}{8}$ in., while directly opposite the $\frac{3}{4}$-in. shell showed no signs of corrosion. The inlet was at the top and the outlet near the top, on the side. The outlet pipe ran down inside to about eight inches from the bottom, and the point of rupture was directly under it. The tank was vented from the top and was clean, also the valve on the discharge was wide open, as the bent stem showed.

Referring to the illustration, the fracture occurred at the bottom, as shown. The pipe shown inside the tank is the discharge. The tank stood in the corner beneath the broken piping. The pipe shown in the vertical position was the vent pipe and originally was horizontal, connecting at the top of the tank. The explosion drove the tank up against the flue, shearing the rivets and bending the angle iron above the boiler back doors upward enough to allow the doors to pass under it; they were struck during the downward course of the tank.

Pipe fittings that were on the rack shown at the right were blown about, and the weights of a damper regulator, not shown, were hurled back of another boiler,



RESULT OF EXPLOSION OF BLOWOFF TANK

one of them striking the engineer, who was blowing down No. 2 boiler. All lights in the boiler room were put out at the time. The engineer "stuck" and shut off the blowoff, although he was bruised and his arms and face were somewhat scalded.

Seizure of Fuel

An opinion of the United States District Court for the Southern District of Ohio defines the right of a railway company to seize coal shipments, as against a person to whom the shipper intended to make delivery.

In the Ohio case—Springfield Light, Heat and Power Co. vs. Norfolk & Western Railway Co.—it was decided that where a railway company accepts a shipment of coal designed for delivery to the shipper's customer, the company cannot seize the coal without becoming liable in damages as for wrongful conversion.

But it is held that where a shipping coal operator is in default under a contract to furnish the railway company's fuel requirements, the company may refuse to accept for transportation coal loaded on its cars, for delivery to the company's intended customer, and retain the fuel for application on its contract with the operator.

Oscar C. Merrill, Secretary of the Federal Water-Power Commission

OWING to the small amount of governmental work pertaining to water powers, few specialists in that subject have been developed in the Federal service. Foremost among these, however, is Oscar C. Merrill, who has just been designated executive secretary of the Federal Water-Power Commission.

Mr. Merrill was born in Manchester, Maine, in 1874. He attended high school at Augusta and Lisbon Falls, Maine, and later entered Bates College from which he was graduated in 1899. After two years as an instructor in the high school at Lubec, Maine, he entered the Massachusetts Institute of Technology, graduating in 1905. In the autumn of 1905 he became an instructor in engineering at the University of California.

In 1906 he began consulting work with Charles G. Hyde, specializing in power and sanitary engineering.

In May, 1909, Mr. Merrill was engaged by the Forest Service to make a special study of water powers in California. In 1910 he was placed in charge of all water powers coming under the jurisdiction of the Forest Service and in 1914 was made chief engineer of the Forest Service, in which capacity he made an exhaustive investigation and report to Congress on the ownership and control of water power sites. As chief engineer he had charge of all water powers, mapping, surveys and road construction. He prepared the regulations which have been followed by the Forest Service and formed the foundation for the present Water-Power Act.

EDITORIALS

Availability and Reliability of Power-Plant Equipment

AVAILABILITY for service is a consideration quite often overlooked by engineers in selecting and installing new equipment. Salesmen handling the machinery wish to present the best possible case for their companies and endeavor to convince their customers that their particular machines can run all the time and need never be out of service. Experience with power-plant equipment indicates that such is not the case and that every machine should receive a thorough overhauling at regular intervals to correct small troubles which may grow serious if allowed to develop. Furthermore, there are periods when the machines are out of service from incidental causes and from inherent troubles.

It is therefore apparent that there is an availability factor for each machine which, if known, would assist engineers greatly in the choice of equipment and particularly in the determination of the number of spare units necessary. Unfortunately, there are no published records of the proportion of time that various classes of machinery are not available for service. It is doubtful if any such records exist. It would therefore seem advisable for engineers to collect data from which "availability factors" can be determined.

Availability for service depends to a large extent on the reliability of the equipment. This leads to a determination of which types are less liable to accident. Every engineer desires to have only reliable machines in his plant. Some types are more susceptible to accident than others. For instance, many of the old-style steam turbines, running at comparatively slow speeds had relatively few accidents as results of vibration. On the other hand, the newer high-speed machines have, in some cases, had considerable difficulty with blading, with vibration and with wear in the bearings. All these difficulties have not been entirely overcome yet, and these considerations will naturally affect the availability factor of such units.

The aim of the machinery builder should be to increase the reliability of his equipment, even at some added expense. In the long run the most reliable machine, since it is available a greater length of time, performs the greatest and most satisfactory amount of service.

Reliability and availability are also dependent on operating methods. For instance, a water-tube boiler will operate at a moderate percentage above rating for a considerable period without needing overhauling. If this same boiler is forced to, say, three hundred per cent rating, its tubes will slag up much more rapidly than the increased overload would indicate, and it will probably require proportionately much more cleaning. The influence of operating conditions will, therefore, be a determining factor in availability.

It is not necessary to discuss the predicament in which an engineer finds himself when a machine fails at the time that his only spare unit is not available. Yet some big plants are being planned with the smallest possible margin of spare units. These may by good fortune "get away with it," but to a conservative engineer it would appear that the availability factor has been given little, if any, careful thought in these designs.

Reserve Strength of Elevator Ropes

ONE of the most important factors in the safe operation of elevator machines is the strength of the cables. When the cables are new, if properly installed they may have a factor of safety of eight or ten, but as they wear and some of the wires in the different strands become cracked, this factor of safety is reduced. The question, How much is the factor of safety reduced with different numbers of wire broken in each strand? has always been debatable. In this issue is published an article, "Reserve Strength of Elevator Ropes," by W. Voigtlander, in which are given the results of a series of tests made on wire ropes to determine their reserve strength under various conditions. Although these tests were made on new cables, they give, if applied with reservations, some idea of what the reserve strength of cables in service may be with various combinations of broken wires per strand.

As a handy approximation of the condition of elevator cables it is general practice to condemn them when six wires per strand are broken. This condition is somewhat similar to that given in test six by Mr. Voigtlander. According to this test a new cable having six wires per strand cut has approximately seventy-five per cent of its original strength; in other words, if in service it had, when new, a factor of safety of eight, with six wires per strand broken this factor of safety would be reduced to six. However, a cable that has been in use for a considerable period, and six wires per strand are cracked, will not have the reserve strength of a new one with the same number of wires per strand broken, on account of the wear and various abuse that the cable may have been subjected to in service. No doubt on the average the reserve strength of a cable in service with six wires per strand broken is nearer fifty or sixty per cent than seventy-five. However, these tests are worthy of careful study by those who are responsible for the safety of elevator operation.

Another interesting subject that Mr. Voigtlander has given valuable data on is the method of socketing wire rope. Undoubtedly his statement, "It has been conclusively demonstrated by repeated tests that the most efficient socket attachment is made by a straight wire brush held in the conical basket of the socket by means of spelter (pure zinc)," will be somewhat of a surprise to many who are familiar with the general practice of socketing cables. It is common practice, and in general is considered the best method, to cut the hemp center out for a short distance back into the cable and turn the ends of the strands back into the center, pull the end back into the basket of the socket and pour it full of a holding metal, usually lead or babbitt.

What can be obtained under ideal conditions with high-grade workmen and that produced by the average workman out on the job are two entirely different things. If cables are socketed by Mr. Voigtlander's method, it is absolutely essential that a high-grade job be done or there is danger of their pulling out of the baskets. On the other hand, where the ends of the strands are turned into the center of the cable, even if the filling metal has not been properly poured, the terminal will stand a large percentage of the maximum stress that it is capable withstanding. There is little doubt that the practice recommended by Mr. Voigtlander is an excellent one where a high degree of care is exercised, but where the average workman is depended on to do the socketing, then the "turned-in" method is to be recommended, if for no other reason than that it offers a higher degree of safety. Further discussion on this subject by *Power* readers would be of general interest.

Burning Coal Under Emergency Conditions

IN THESE days of coal shortage one cannot be too particular as to the kind and quality of coal he buys; more often he is glad to take what he can get as an alternative against shutdown. Therefore, aside from inferior quality, we find many boilers operating with a coal entirely different from that for which the furnace or stoker was designed. Especially is this true in the Middle West, where cases have recently come to our attention of boilers designed for Iowa and Illinois soft coals being compelled to burn coke breeze or anthracite screenings and buckwheat; and this, in one case with high Stirling boilers.

The advent of the mechanical stoker, the forcing of boilers and the elimination of smoke, together with a realization that the boiler room was the place of greatest waste or saving, all have been responsible for much study of combustion; and engineering literature is rich in the results of such investigations. But the aim was always to arrive at a design best suited to the burning of a particular class of coal, and usually under given conditions of operation. There was no thought of building a universal furnace or stoker equally adapted to all coals, because the necessity was not there and it was better engineering to adapt the design to the available fuel. Consequently, there is not available much published information that would aid our friends in the Middle West in the present emergency. However, there may be those among our readers who have had a similar problem, and their experience toward solution will be helpful to others. Discussion of the problem is invited.

Automatic Starting of Synchronous Motors

WHEN a type of electric motor and control equipment is developed to the state where it can perform its function automatically, it is generally considered to be a reliable piece of apparatus. This is apparently what the present development in synchronous motors and synchronous-motor controllers is approaching. Not so long ago this class of equipment was considered one requiring high-class attention to assure satisfactory operation. The experience that G. G. Rehfield gives in a discussion letter, "Synchronous Motors for Driving Centrifugal Pumps," on page 108 in this issue, is very interesting and shows what is possible to accomplish with a synchronous motor of modern type, properly designed for the service to which it is applied.

The early types of synchronous motors required auxiliary starting equipment to bring them up to speed so that they could be first synchronized and thrown on the line as generators, after which the starting machine was cut out and the load thrown on the motor through a clutch or by some other means. If everything was favorable, the motor carried its load without further trouble, otherwise serious difficulty was liable to develop from hunting. The motor Mr. Rehfield discusses starts up automatically and pulls into step in less than five seconds when driving a centrifugal pump fully primed, with all valves open.

The first synchronous motors were for the most part standard-type alternators adapted to motor applications. During the last few years engineers have given careful study to the characteristics of these motors and have attempted to design them with due regard to these characteristics. As a result this class of equipment is today operating satisfactorily on applications which a few years ago were thought impossible.

Fine—If It Could Be Done

EUGENE MACAULIFFE proposed to the Interstate Commerce Commission in its coal hearings on July ninth that it require the railroads to move from the mines not less than two million tons of coal per working day for the next three months, and 1.9 millions per day for the next two months. Thus there would be established a daily required performance which he estimated would be adequate to supply this year's coal, and to which all parties in the much disputed coal matter would agree as fine. But—

Eight hours sound sleep each night is, in our humble lay opinion, the finest cure for insomnia known. But the M.D. who would so prescribe for this malady might find his patients were not wholly responsive to orders. We fear that the railways are likely to be about as difficult to handle in their present state of ill health.

Nevertheless, the basic fact remains that this minimum amount of coal must be moved if we are to get along this year. Perhaps the most successful measure by which we may insure its movement is to put this responsibility directly upon the carriers. If they can move other classes of freight only after their coal-handling job is done, maybe we have created the best possible incentive to do this necessary task.

The manager of a Texas company recently wrote the Geological Survey asking the Director's opinion of the efficiency of his power plant, which his returns show consumes one barrel of oil for each thirty kilowatt-hours. He was anxious to know whether his consumption was above or below the average of plants reporting to the Survey. Dr. Smith advised him that in Texas the average consumption of oil is one barrel for each two hundred kilowatt-hours. In addition, the Texan was informed that there are two oil-burning plants in Arizona which average nearly three hundred kilowatt-hours to the barrel of oil. Dr. Smith suggests that this correspondent probably will have no grievance regarding the interference of the Federal Bureau in the affairs of his private company.

CORRESPONDENCE

The Economy of Non-Condensing Turbines

John A. Stevens, in his article, "Economies To Be Expected of the Superstation," in the June 1 issue, brings out points regarding the economy of non-condensing turbines which are of great importance.

His curves, Fig. 6 and Fig. 7, show that, making proper allowances for the heating value of the exhaust steam, a 4,000-kw. non-condensing turbine, even when running at the unusual back pressure of 80 lb., produced electricity at a water rate per kilowatt-hour of 4 lb. to 5 lb. actually chargeable to power. No condensing turbine can approach such a performance.

The superior economy of non-condensing turbines, when the exhaust steam can be utilized, is of course due to the fact that no heat is lost to the condensing water.

There are only three ways in which the heat energy in the steam entering a non-condensing steam turbine can go:

1. In the form of useful work. Regardless of the water rate of the turbine, the heat energy converted into work is 2,545 B.t.u. per horsepower-hour.

2. Escape to the atmosphere. This item includes radiation, the heat from bearing friction and from steam leakage.

3. As heat in the exhaust steam. This heat includes the energy dissipated by all the internal losses in the turbine.

The only energy loss is in Item 2, which may be kept small compared to Items 1 and 3, with resulting very high efficiency of utilization of the heat in steam.

It is safe to say that when the exhaust steam can be utilized for heating or industrial processes, power can be produced by a non-condensing steam turbine with far less consumption of fuel than by a condensing turbine, either directly or through motors.

One very significant clause in Mr. Stevens' article reads, " . . . it is suggested that power contracts be made with the permission to manufacture what power is desired by byproduct turbines—that is, byproduct to power production. . . ."

For best economy, and minimum national fuel consumption, those buildings, manufacturing plants, etc., which require considerable steam for heating or industrial processes, should generate steam at reasonably high pressure and use it first in generating power before putting it into the heating mains. If a non-condensing turbo-generator set is used, tied in with an electrical distribution system from a central station, it will be possible to carry just enough load on this unit to supply the required exhaust steam. The additional fuel for generating power will be far less than in the most efficient condensing unit possible.

This feature should be brought out more prominently in connection with superstation discussion, as it is a vital one. Many engineers now have a mistaken idea that the construction of a few very efficient large power stations would eventually do away altogether with the small plant. Mr. Stevens' article is a valuable contribution on the subject of national fuel conservation and will bear careful study.

M. D. CHURCH,
Chief Engineer, Terry Steam Turbine Co.
Hartford, Conn.

Compressor Used Wet Steam

On a recent visit to a large manufacturing plant in Buffalo, I noticed that the main steam-driven duplex air compressor, which supplied compressed air to the various pneumatic tools throughout the plant, was in continual operation. Instead of shutting it down when there was sufficient air in the tanks, the governor was apparently adjusted so that the compressor turned over slowly until the air tanks needed replenishing. It is the ordinary practice to have the governor adjusted to shut off the steam supply when the air tanks are filled to capacity, and so I naturally concluded that considerable steam was being wasted, since the compressor was kept in operation all day and shut-off periods were of considerable duration.

The chief engineer quite agreed with me and took me out to the boiler room, where I saw a very faulty piping installation. The steam pipe feeding the steam cylinders of the compressor joined the main steam line of the plant at the bottom of the main and within two feet of the feeder from the boiler. With this installation all drip and condensate and any foam from the boiler naturally went along with the live steam to the compressor, making it necessary to keep the latter in continual operation to prevent the accumulation of water in the compressor or supply line and steam cylinders during periods when the air tanks were filled.

It seems to me that the application of a little common sense when this installation was first made would have resulted in a considerable saving in view of the fact that the compressor has been operated as outlined for the past eight years.

East Orange, N. J. HOWARD S. FISHER.

Synchronous Motors for Driving Centrifugal Pumps

In the Jan. 20 issue of *Power* Soren H. Mortensen discussed synchronous motors for driving centrifugal pumps. The starting characteristics were further discussed by B. S. Stevens in the April 13 issue by presenting additional data from a synchronous motor driving an ammonia compressor. To bring out additional data presentation is made herewith of a graphic record of the starting of a synchronous motor driving a centrifugal pump installed in Morris & Co.'s plant at Chicago. Fig. 1 shows the chart incorporated in Mr. Mortensen's article, giving the current taken and the time required for starting a centrifugal pump from stand-still to full speed, with the discharge valve closed. Fig. 2 is the chart taken by the writer on a 3,000-gal. centrifugal pump working under a head of 140 ft., the pump being driven by a 160-hp. 440-volt two-phase 60-cycle 1,200-r.p.m. motor of the self-starting, self-synchronizing type. This chart shows two complete starts, and it is to be noticed that the pump was started fully primed with the foot valve on the suction, the discharge valve wide open and the starting compensator set on the 50 per cent voltage tap. The chart is self-explanatory and reads from right to left.

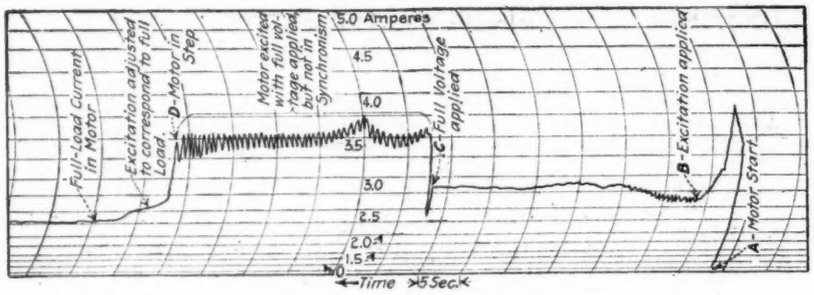


FIG. 1. RECORD OF CURRENT TAKEN DURING STARTING BY SYNCHRONOUS MOTOR DRIVING CENTRIFUGAL PUMP

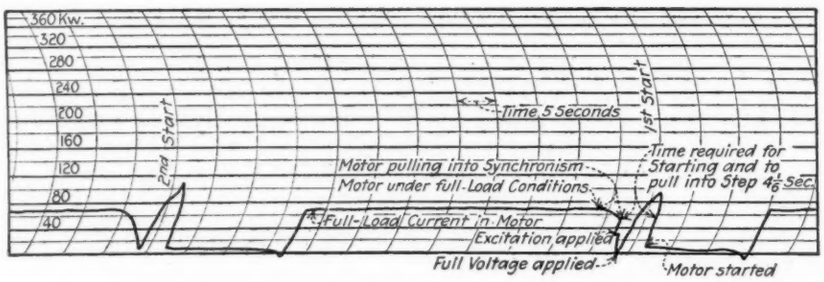


FIG. 2. RECORD OF CURRENT TAKEN BY AUTOMATICALLY STARTED SYNCHRONOUS MOTOR DRIVING CENTRIFUGAL PUMP

From the time the first voltage was applied to the motor until the latter had pulled into step under full-load conditions, approximately 4⅛ seconds had elapsed. The sharp peak as the motor started shows approximately 90 kw. drawn from the line, while the rapidly descending curve for a few seconds shows a rapid increase in speed of the motor, and of course, as the motor approaches near to full speed, a rapidly increased power factor.

It will be noticed in the curve that excitation was not applied until full voltage had been put upon the motor; and when excitation was applied, the motor pulled into step almost instantaneously. Results are entirely different from those obtained from Mr. Mortensen's method of applying the field, soon after the reduced voltage is applied to the motor. Throwing on the field before full voltage is applied to the motor simply retards the operation by prolonging the time required for the motor to reach full speed and pull into synchronism. The curve shown in Fig. 2 is a beautiful example of what can be done with a synchronous motor. To my knowledge no chart has been published previously showing where a synchronous motor has started from rest and pulled into step at full load, or approximately full load, at the pull-in point. It is admitted that the motor is a little large for the mechanical load it has to pull; but this has nothing to do with the characteristics shown in the curve. The primary idea is to show how a synchronous motor of good design can be started and put into service under full load, drawing the minimum amount of power from the line, with a continuous oncoming load being applied. It is my belief that the secret of the results obtained lies in the construction of the rotor, particularly the squirrel cage winding or starting winding as it may be called, and also in the large pole embrace and the small space between pole tips, which means a reduced electrical air gap for the motor and at the same time does not sacrifice the actual mechanical or running air gap. With a rotor designed to reduce the effective or electrical air gap to a minimum and thereby decrease the reluctance of the magnetic circuit, it is possible to secure a much larger starting torque with the same

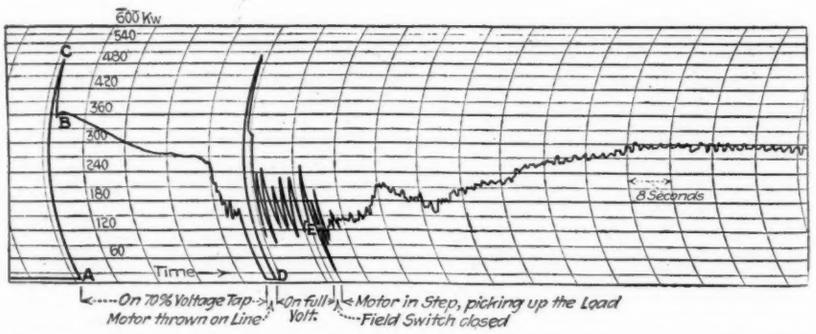


FIG. 3. RECORD OF CURRENT TAKEN DURING STARTING BY SYNCHRONOUS MOTOR DRIVING AMMONIA COMPRESSOR

kva. taken from the line, or with same starting torque to be produced, the kva. from the line will be reduced.

Specifications on the machine as purchased are as follows:

Horsepower output	150
Kilovolt-amperes at unity power factor	119
Amperes per terminal	135
Per cent overload	0
To be used for continuous duty	

Following are the starting data as guaranteed:

Starting voltage in per cent of full voltage	45
Starting torque in per cent of full-load torque	30
Starting kv.a. in per cent of full-load kv.a.	105
Pull-in torque in per cent of full-load torque at 45 per cent full voltage	18
Pull-in kv.a. in per cent of full-load kv.a. at 45 per cent full voltage	105

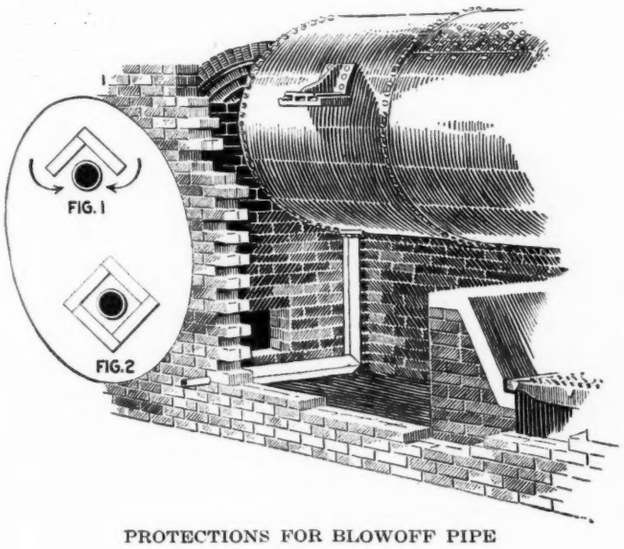
The efficiencies guaranteed at 100 per cent power factor are 91.5 per cent at one-half load, 93.1 per cent at three-quarter load and 94.4 at full load.

The foregoing has been given to bring out a more full discussion of the use of the synchronous motor in general. Although the present material has been confined to synchronous motors driving pumps, there is much to be said on other types of drive for synchronous motors, such as the ammonia compressor, on which B. S. Stevens had something to say in the April 13 issue of *Power*. In another article the writer will present data from a similar unit operating under practically the same conditions.

G. G. REHFIELD,
Chicago, Ill. Electrical Engineer, Morris & Co.

Blowoff-Pipe Protection

A short letter in a recent issue told of a blowoff pipe that burst owing to being burned on account of not being properly protected. I had a similar experience at one time. Although the pipe was covered by a V-shaped baffle, as shown in Fig. 1, I have found that this design of baffle does not afford sufficient protection



PROTECTIONS FOR BLOWOFF PIPE

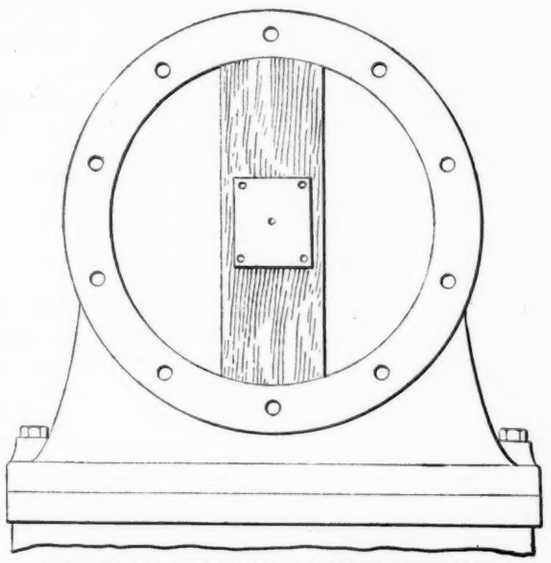
as the hot gases back in around the pipe, as shown by the arrows, and a burned pipe is the result. After having one blowoff pipe burn out, I hit on using a protection built as shown in Fig. 2, which permits air to enter the space between the baffle and the pipe where it goes through the back wall. I have, in service, three blowoff pipes so protected which are as good as new after five years' use.

L. A. COLE.
Black Lick, Ohio.

Overhauling and Aligning the Engine

I have tried Mr. Airey's method of centering the line in the head of a cylinder, as described on page 764 of the May 11 issue, and found it tedious and open to inaccuracies when used by the average engineer.

I fit a dressed board, size about 1 in. by 6 in. in the counterbore with an inch hole in the center of the



CENTERING BOARD FOR LINING UP ENGINE

board. Over this hole I tack a piece of tin, mark the center of the cylinder on the tin, and punch a small hole through this center. The line is passed through this hole and is firmly held without any more measuring at that end of the cylinder.

W. A. COOIL.
Esplanade, B. C.

Electric-Arc Versus Gas Welds

I have read with considerable interest Mr. Miller's comments on my article on "Electric Arc Versus Gas Welds," published on page 934 of the June 8 issue of *Power*. Mr. Miller seems to assume that my statements regarding the superiority of the arc weld were based upon a few experiences in which I have been fortunate enough to have secured the services of competent arc welders and equally unfortunate in having only incompetent gas welders. Such however is not the case. I have had under my supervision, directly and indirectly, considerably over one hundred welders, over half of whom were gas welders. Some of the arc and some of the gas welders were very competent, some far from competent, but this fact did not affect the general average results obtained.

I also have examined hundreds of welds made in various metals and have made numerous tests and practical observations of arc, thermit and gas welds, and the results of these observations and tests were such as to place the electric arc weld first, the thermit weld second and the gas weld last in practical value and general adaptability. Mr. Miller states that a lack of thorough fusion is as likely to take place with an arc as with a gas weld. I have not found such to be the case, as with the extreme difficulty of localizing the heat when making a gas weld, there

are likely to be portions of the weld in which imperfect fusion has occurred; this owing to these places not having been brought to a proper welding temperature. With the arc weld the metal is deposited in the weld by the so-called instantaneous fusion process and imperfect fusion is not nearly as liable to occur.

In mentioning some tests made on are welds, Mr. Miller quotes the tensile strength as varying from 18,000 to 65,000. In order to answer this statement more data would be essential such as to the test specimens, welding system used, original metal, electrodes used and the physical properties of the weld (aside from the tensile strength), as the tensile strength alone is no criterion of a weld. The tensile strength does not follow with equal ratio the elasticity, enlongation and other valuable properties. I have increased the tensile strength of a welded specimen by hammering the weld, but I can assure the reader that I did not increase certain other essential properties by this operation.

Mr. Miller states that good welding can be done with all types of arc machines. This, to a great measure, I believe to be so, but I would qualify that statement in that some machines are capable of doing very much better welding than others. His statement that certain processes are best for certain classes of work I also agree with. But the jobs where the gas weld is the best are so few as found in plant repair work that I use the gas process for the cutting of metals only.

If I were to have a large quantity of thin sheet metal to weld, I would use the gas process, as I believe it best for that class of work. But in welding castings or other work where there is so great chance of failure by shrinkage or contraction stress, I would not consider making a gas weld if the arc-weld apparatus was obtainable. Even in cast-iron welding where users of the gas torch claim such advantage gained in the deoxidizing agency of the reducing flame, I would still prefer the arc weld, even if steel studs or reinforcement pieces were found necessary, this being on account of the severe contraction stresses set up consequent to the preheating required by the gas-welding system and the uncertainty that such stresses have been relieved by any after heat treatment used. I am not prejudiced in favor of any particular welding system except that I have used both for a number of years and have discarded the poorer for the better.

A word in regard to the propeller welding: Mr. Miller states that he would guarantee to weld these propellers satisfactorily by the oxy-acetylene process. Several other jobbing firms and the repair department of one of the leading manufacturers of gas-welding equipment agreed to do the same thing. Their welds on the propellers failed in a very short time; and although they lost the time spent on the welding and the gas used, this was a small item beside the amount the boat owners were out for the expense of docking vessel and renewing propellers after these failures. Another peculiar circumstance was this: Although on a propeller of four blades a different welder was employed on each blade with the gas process, still all the welds failed and failed in exactly the same manner; while with the arc welding process there were also four welders employed, each on a separate blade, and none of these welds failed. According to Mr. Miller the four gas welders were incompetent, the four arc welders competent, and the process used in no way at fault. This does not appear reasonable to me.

I have recently welded by the arc process a monel-metal runner shaft on a high-speed centrifugal pump, machined the same with ease, and it is in use and giving every satisfaction. The bronze and composition jobs that I have done by the arc process are far too numerous to mention. I find that in certain alloy welding the amperage and arc length are of fully as great importance as the copper ratio.

In regard to Mr. Miller's statement that no jobbing shop would take a chance on welding a cast-iron press frame by the electric arc process, last October a 3,000 ton cast-iron press frame was welded by the arc process by a jobbing shop which uses only that process and 2,194 lb. of metal had to be fused into the weld, so badly was the frame fractured. This press has been employed since that time under especially severe conditions, and with no sign of failure in the weld or elsewhere. This is only one of many repairs to cast-iron press frames by the arc process that have come under my observation.

Anyone has only to ask for the advertising matter of the many jobbing shops which do only arc welding, to find how very many of them are glad to tackle a cast-iron press frame job and furnish all required guarantees. If Mr. Miller cares to visit my shop at the present time, I will be very pleased to show him an arc weld I am making of a cracked high-pressure cylinder of a 3,500-hp. steam engine, boiler pressure 225 lb., and I can assure him that I anticipate no difficulty in making the weld and no failure after the work is completed.

C. T. PERRY, M. E.

Staten Island, N. Y.

Repairing a Boiler Plate Lamination

Although I should hesitate to use the welding process to join the plates in a boiler shell, instead of using rivets, I see no reason for worry as to the consequence of filling a lamination by means of the electric arc, as stated on page 817 of the May 18 issue of *Power*.

A patch and rivets might be preferable to the oxy-acetylene process on account of the heating of the surrounding plate. As stated in my original letter, there was $\frac{3}{16}$ in. of good plate. The metal was thoroughly cleaned and the edge of the cavity beveled. The cavity was then filled above the surrounding plate and the surplus metal ground off. A recent inspection of the part, which would have been difficult to locate if we did not know where it was, showed that it was in good shape and a hammer test failed to show any fault.

This method of repairing will naturally fail to meet favor with boilermakers, but that fact should not interfere with improvements in doing work.

Toronto, Ont., Canada. R. MCLAREN.

Study the boiler conditions and provide a way to weigh the coal, measure the feed water, rate of combustion, the necessary draft, install water heating and reheating devices and take the temperature readings at different points at stated intervals.

Putting the plant in a good conditions is not all. A good plant badly operated or neglected will show very low efficiency; a poor plant skillfully operated will show comparatively high efficiency.

INQUIRIES OF GENERAL INTEREST

Heating Surface of Closed Feed-Water Heaters—What number of square feet of brass-tube heating surface is allowable per boiler horsepower for closed exhaust-steam feed-water heaters? R. W. R.

For heating feed water from 60 to 190 deg. F., allowing 30 lb. of water required per hour per boiler horsepower, the usual allowance is ½ sq.ft. of heating surface per boiler horsepower and for heating the water from 60 to 204 deg. F., ½ sq.ft. per boiler horsepower. The actual surface required depends on the condition of the heating surfaces; that is, whether clean or coated with grease or scales, and also depends on the character of circulation.

Advantage of Increasing Feed-Water Temperature—In the generation of steam at 100 lb. per sq.in. gage pressure, what percentage of saving is effected by heating the feed water by exhaust steam to 190 deg. F. in place of 110 deg. F.? R. N.

By referring to steam tables, it may be seen that a pound of steam at 100 lb. per sq.in. gage, or 115 per sq.in. absolute, contains 1,188.8 B.t.u. above 32 deg. F., and with the feed water at the temperature of 110 deg. F., or 110 − 32 = 78 deg. F. above 32 deg. F., each pound of the feed water for conversion into steam requires 1,183.8 − 78 = 1,110.8 B.t.u. If the feed-water temperature is 190 deg. F., then for conversion into steam each pound of the feed water would require 190 − 110 = 80 B.t.u. less, and the saving would be 80 ÷ 1,110.8 = 0.072, or about 7 per cent, provided there is no loss from additional back pressure on the engine.

Heating of Induction Motor—We have a three-phase, 3-hp., 220-volt induction motor which was rewound recently. The motor is star connected, runs up to speed and drives its load satisfactorily, but heats up evenly all around the stator, though not dangerously. What causes the heating? Would it be prevented by changing to a delta connection? J. E. F.

From the statement, it does not appear that there is anything wrong with the motor. If it heats up evenly all around the stator but not dangerously, that is true with any motor, even when operating under no load. It is understood that the machine was rewound by putting in the same kind of a winding that was originally on the motor. Changing from a star connection to a delta would only make matters worse, and probably the motor would not operate at all. A star connection will operate on 58 per cent higher voltage than a delta connection, and if the motor does not heat excessively and does its work satisfactorily, there is no ground for complaint.

Trouble with Glass-Gage Breakage—Much trouble is experienced with breakage of water-gage glasses on one of our boilers. What may be the cause and the remedy? W. R.

The durability of a water-gage glass depends largely on the method of packing the glands and on proper alignment of the gage-glass fittings. Test the alignment by placing through the fittings a round bar turned to the size of the bushings. A new glass should have a diameter not less than ¼ in. less than the bore of the gland nut and bush, and the glass tube should have at least ½ in. end play to allow for expansion, observing, however, that the glass is long enough to prevent the packing from being forced over the end of the glass and cause obstruction of the glass-tube ends or the passages of the fittings. Tighten up the top and bottom gland nuts alternately. With the fittings in good alignment and glands properly packed, sufficiently tight joints should be secured from screwing up the gland nuts by hand, or at most by a gentle touch with a wrench. If the glass tube cannot be turned with the comparative ease by the finger and thumb after the gland nuts have been set pressure tight, it may be taken for granted that the glands are improperly packed or that the fittings are out of line.

Size of Instrument Transformer—How are the sizes of potential and current transformers for a polyphase meter determined? For instance, we have a polyphase wattmeter rated at 60 cycles, 80 amperes, 110 volts, connected to a three-phase 2,300 volt supply circuit through potential and current transformers. The potential transformers are marked "20:1 ratio, 0.05 kva." and the current transformers are marked "2,500 to 4,500 volts 16:1." V. K. S.

Current transformers are, in general, designed to give 5 amperes on the secondary at full load, and all ammeters, wattmeters, power-factor meters, etc., are designed, when supplied from current transformers, for 5 amperes in the current coil. Potential transformers are usually designed to step the voltage down to 110 volts, the transformers themselves to have 0.05 kilovolt-amperes capacity. This is standard practice, although sometimes there are exceptions made to this rule, which are special cases.

Boiler Horsepower for Stated Evaporation—How many boiler horsepower will be developed by evaporation of 100 cu.ft. of water per hour from a feed temperature of 50 deg. F. into steam at 150 lb. per sq.in. gage pressure? R. L. K.

A cubic foot of water at the temperature of 50 deg. F. weighs 62.4 lb., and 100 cu.ft. would be 6,240 lb. One boiler horsepower is equivalent to evaporation per hour of 34.5 lb. of water from and at 212 deg. F., each pound requiring the latent heat of evaporation at 212 deg. F. which, as ascertained from steam tables, would be 970.4. By further reference to the steam table it may be seen that a pound (by weight) of steam at the pressure of 150 lb. gage, or 150 + 15 = 165 lb. per sq.in. absolute, contains 1,195 B.t.u. above 32 deg. F. With feed water at the temperature of 50 deg. F., or 50 — 32 = 18 deg. above 32 deg. F., each pound of the feed water would receive 1,195 — 18 = 1,177 B.t.u., or 1,177 ÷ 970.4 = 1.2129 times as much heat as required for its evaporation from and at 212 deg. F. The quantity 1.2129 would be the "factor of evaporation" for the stated conditions of feed water temperature and the pressure at which the steam was generated and evaporation of 6,240 lb. of water per hour would be performed at the rate of 6,240 × 1.2129 ÷ 34.5 = 219.38 boiler horsepower.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

The Separation of Dissolved Gases from Water*

LABORATORY tests of a method for removing dissolved gases from water having demonstrated its commercial utility, further experiments were made on commercial apparatus, and the general conclusions are presented in this paper. The process consists of the rapid injection of heated water into a region of vacuo, the explosive boiling of the water by the heat of the liquid and the recovery of the heat liberated by a condenser cooled by the incoming water on its way to the heater. It is demonstrated that this process is

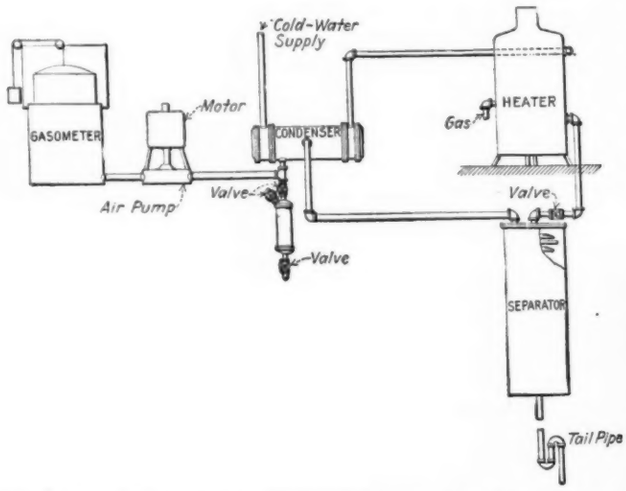


FIG. 1. LABORATORY APPARATUS FOR THE SEPARATION OF DISSOLVED GASES FROM FEED WATER

able to handle water in quantities suitable for power-plant boiler feed, that it is capable of removing all the dissolved gases in a commercial sense, and that this involves no method or apparatus with which the average operating engineer is not familiar.

The laboratory apparatus is shown diagrammatically in Fig. 1. The water to be treated was heated in a gas water heater which delivered the hot water to the separator. The latter consisted of an airtight steel tank with a series of copper return-cascade trays, over which a sprayhead delivered the water uniformly in a thin sheet. A vacuum being maintained in the separator, some of the liquid boiled explosively, and the resulting vapor and any free gases were carried off to the condenser, which was a small commercial machine of the surface type. Here all the vapor was condensed and the heat reclaimed by using the water on its way to the heater as cooling water. The separator tank was connected with a barometric tail-pipe to remove the treated water. The condenser was drained out through a small receiver and trap and the non-condensable gases were drawn out by the air pump and delivered to the gasometer for measurement. It was found that the gasometer method of measuring the volume of non-condensable gases was not of consistent accuracy with the rest of the data, and it was therefore necessary to resort to direct testing of the water which had passed through the process. The method finally adopted was the iodiometric titration method of Winkler for dissolved oxygen.

At the conclusion of about four months' intermittent testing the apparatus was taken apart and examined. Steel tanks, copper pans and condenser gave evidence of very accelerated corrosion, and this led to the use of cast iron and non-corroding bronzes in the construction of the first commercial apparatus. These materials have withstood the corrosive tendencies for over four years of experimental operation. The laboratory experiments developed a further fact, that the water which has been passed through this process and completely degasified has an enormous avidity for redissolving small amounts of air. In any practical application of the process, therefore, absolutely rigid exclusion of air must be maintained if the full benefits are to be secured.

After the success of the laboratory apparatus was demonstrated, a commercial installation was made at the Jeannette, Pa., works of the Elliott Co., of Pittsburgh, and this apparatus has been in routine operation since the autumn of 1915. The separator consisted of a 1,000-hp. Elliott cylindrical heater shell with modified water injection, different proportions of water storage volume and pan area and a change of material to resist corrosion. At the outset a 300-hp. open feed-water heater was installed to supply the hot water, and the vacuum was maintained by a rotary motor-driven dry air pump in series with the condenser. The drip from the condenser was allowed to drain directly back to the separator and the air pump discharged directly to the atmosphere, otherwise the scheme of connection was

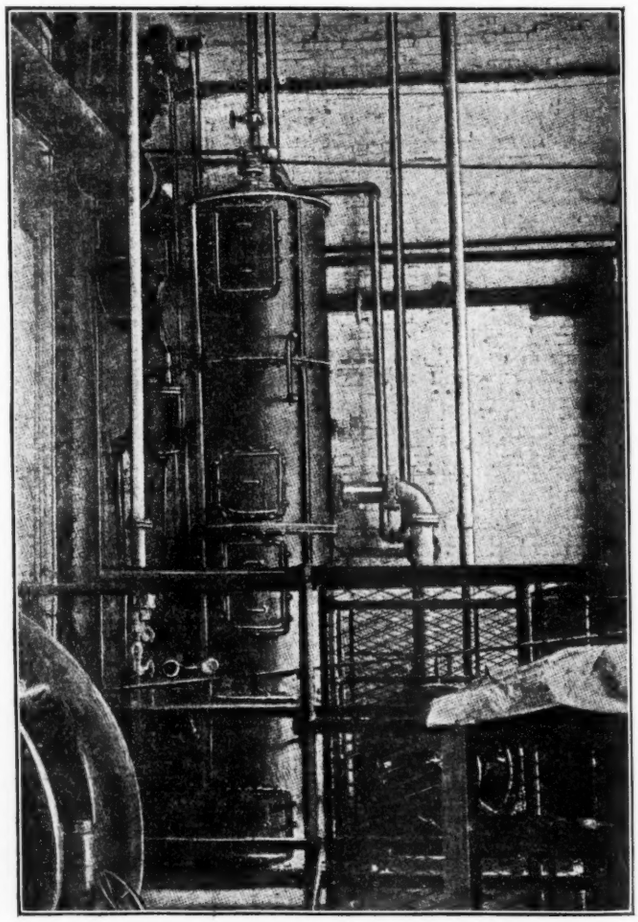


FIG. 2. INTEGRAL VERTICAL-UNIT COMMERCIAL TYPE OF APPARATUS

identical with that shown in Fig. 1. Later, an increase in boiler capacity necessitated a 1,000-hp. heater, and an Elliott shell-type heater similar to that used for the separator was installed and the whole outfit repiped and made into an integral vertical unit. This heater-separator unit is shown in Fig. 2. A steam injector was substituted for the rotary air pump, and the condenser was mounted on the atmospheric side to recover the injector steam, the condenser drainage being now to the heater instead of to the separator.

*Abstract of a paper presented by J. R. McDermet at the Spring Meeting at St. Louis, May, 1920, of the American Society of Mechanical Engineers.

The mechanism of separation appears to depend on three factors: The natural decrease of solubility with temperature increase, the mechanical agitation of boiling and the reduction of pressure. The reduction of solubility with heating amounts, roughly, to 70 per cent of the volume at normal temperature, and separation to this extent was arbitrarily credited to the heater. Water at 212 deg. F. injected suddenly into the vacuum in the separator boils with explosive violence. Vapor bubbles form upon minute entrained air bubbles and in passing off into the region of reduced pressure, mechanically carry some of the dissolved air with them. By far the major portion of the separation, particularly in the elimination of the final traces of dissolved gases, is accomplished by reduction of partial pressure. With a separator water-storage volume corresponding to two minutes' operation at rating, it is impossible to detect any temperature depression in the vapor mixture or in the water leaving the separator, below the vapor temperature corresponding to the vacuum. The most logical conclusion from this is that with the continuous sweep of the wet dense water vapor from the separator, the air component of the total pressure has been reduced substantially to zero.

Fig. 3 is plotted with percentages of separation as ordinates and vacuum referred to a 30-in. barometer as abscissas

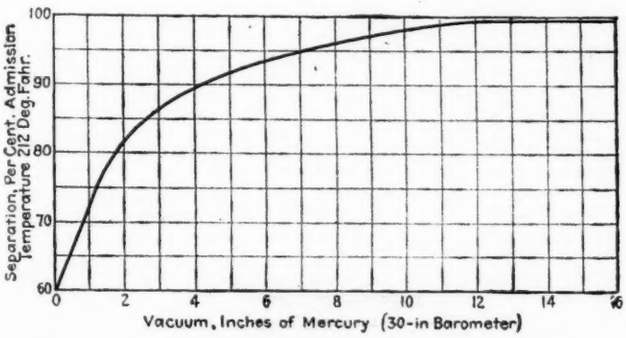


FIG. 3. RELATION BETWEEN AIR SEPARATION AND VACUUM FOR 212 DEG. F. WATER TEMPERATURE AT ADMISSION TO SEPARATOR

for a water temperature at admission to the separator of 212 deg. F., corresponding to atmospheric equilibrium. This plot is a graphical average of a large number of determinations made both with the laboratory and a commercial-sized apparatus. Percentage of separation is defined for the purposes of these curves as the ratio of the quantity of gases removed to that actually present in the raw water, and the calculations were made in terms of volume. At separation values much in excess of 95 per cent, the quantity of gases remaining is so exceedingly small that accuracy of testing is a limiting feature in extending the conclusions to this range. It is the writer's frank opinion, however, that the flat portion of the curve in Fig. 3 represents complete separation of the gases, but it is impossible to prove it.

This work was undertaken as an industrial-research problem with the expectation that it would have two distinct fields of usefulness: The elimination of boiler and economizer corrosion in boiler plants, and of that of the entire distribution system in central-station heating; and the improvement of conductivity in surface condensation of steam. It developed in the course of experiment that it had additional merit in the removal of dissolved and half-combined carbon dioxide. The matter of corrosion has received wide attention from the engineering profession, and the pernicious effect of dissolved oxygen is unquestioned. A high-pressure steam boiler is so complicated a chemical factor that there can be no general panacea for its ailments, but the removal of dissolved oxygen and carbon dioxide is a decidedly effective step in the elimination of corrosion.

The removal of carbon dioxide and oxygen will also, undoubtedly, prolong the life of cast-iron economizer tubes and will make the installation of steel-tube economizers economically practical and conservative.

The bicarbonates of calcium and magnesium are soluble in water in any proportions in which they are likely to exist in natural supplies. They will, however, readily part with their carbonic acids under the conditions existing in the separator equipment, thereby being reduced to carbonates which may be precipitated before entering the boiler, thus avoiding the scale troubles from this class of compounds. The elimination of the carbon dioxide by this apparatus, therefore, should help in the solution of scale problems as well as in those of corrosion.

Exhaustive tests were made to determine the effect of air removal on the conductivity of heat in surface condensers. These tests show that the removal of air would cause an increase in conductivity of about 20 per cent based upon the entire area of the condenser. The economical limit of the removal of heat by the cooling water after it has been conconducted will probably, however, limit conductivity to substantially the same values that are used in commercial practice today. Since in part of the condenser the heat transmission is from steam through metal to water, and in another part, from water through metal to water, and since the rate of heat transmission in these zones is so radically different, it is impossible in tests on condensers of different types with air-free steam to arrive at any data with which to formulate or verify laws.

It is possible, then, from the data of this paper to design apparatus that will accomplish the separation of dissolved gases from boiler water as completely as it may economically be desired to do it. Control of the process is secured through regulation of the temperature drop of the water in passing into and through the region of vacuum. The benefits to be derived from this removal of dissolved gases are at least a partial elimination of corrosion in boiler and economizers, the precipitation of dissolved bicarbonates and therefore a partial solution of the scale problem and a gain of approximately 20 per cent in the conductivity of surface condensers upon the condenser area as a whole.

Mr. Speller's Discussion of the McDermet Paper

The following is an abstract of a written discussion of Mr. McDermet's paper by F. N. Speller, metallurgical engineer, National Tube Co.

The method of mechanical de-aëration described by Mr. McDermet affords another means whereby the gases may be removed from water, and illustrates again that the practical solution of the corrosion problem is mainly a question of special engineering design. At temperatures below 180 deg. F. our experiments have shown that the last 0.5 c.c. per liter (0.116 cu.in. per gal.) of oxygen is much more difficult to remove by mechanical means, while above 180 deg. F. equilibrium can be easily obtained when the temperature approximates the boiling point for the prevailing pressure.

The oxygen content (which is closely proportional to dissolved air) varies from 5 to 10 c.c. per liter (1.16 to 2.31 cu.in. per gal.) in natural water according to seasonal temperature. As it is simple enough to remove most of the gases without any special apparatus other than a well-vented heater, it is perhaps better not to consider percentage removal of gases, but rather as to how much remains after leaving the heater and how best can this residual oxygen be removed. The variation in reduction of dissolved air reported from 10 to 70 per cent at 212 deg. F., if I interpret these figures correctly, indicates the use of an undersized open heater. It would seem more desirable to plan to remove dissolved gases as far as possible in the heater. An open heater operating at the National Tube Co., McKeesport, Pa., at a temperature of 170 deg. F. left a daily average of 2.55 c.c. per liter (0.589 cu.in. per gal.) of free oxygen in the feed water, the theoretical minimum for these conditions being 2.35 c.c. per liter (0.543 cu.in. per gal.). Another series of tests made at another plant with an open-heater temperature of 204 deg. F., gave us 0.75 c.c. (0.173 cu.in. per gal.) residual oxygen, the theoretical minimum under these conditions being 0.50 c.c (0.116 cu.in. per gal.) per liter. A test on a large open heater at the Philadelphia Electric Co., reported to me by Mr. N. E. Funk, gave 0.70 c.c. per liter (0.162 cu.in. per gal.) in feed water leaving the heater at 209 deg. F. with some corrosion in economizer tubes, but much less than before when

the heater was operated at 148 deg. F.; the feed water after heating in this case carried 2.06 c.c. per liter (0.475 cu.in. per gal.) of free oxygen. We have shown, however, that it is possible to approach quite close to the theoretical minimum oxygen in an open heater by a larger area of baffles or by spraying the water.

The method of collection of sample is not described and may have a bearing on the heater variations Mr. McDermet refers to. In taking samples of hot water under pressure for oxygen determination, we draw the sample slowly while under pressure through a copper or tin coil immersed in ice water so that, when drawn into sample bottle, the temperature of the water is about normal. This insures retention in solution of all gases, and if the sample tube extends to the bottom of the bottle, a sample can be collected in a minute or two without agitation and without reabsorption of air.

Corrosion Proportional to Free Oxygen in Solution

The amount of residual oxygen that will cause serious corrosion in a given time varies with the temperature at which the water is used. It has been demonstrated experimentally by the work done by Dr. W. H. Walker of the Massachusetts Institute of Technology and ourselves that corrosion of piping is closely proportional to the free oxygen in solution. Several years' experimental work on mechanical and chemical de-aëration has been done at the Massachusetts Institute of Technology and National Tube Company Research Laboratories in co-operation, and several plants have been put into service to test out these principles in hot-water supply systems for buildings and in central heating stations and power plants to develop the best type of apparatus for such service. This experience indicates that feed water used with steel economizers should carry less than 0.20 c.c. per liter (0.046 cu.in. per gal.). The foregoing tests therefore indicate that open heaters, as usually operated, will not reduce the oxygen low enough to stop corrosion.

The residual oxygen in feed water after passing through a properly vented open heater may be reduced below the danger point by further mechanical de-aëration such as passing the water from heaters over baffles at about the boiling point in a separate chamber at lower pressure (no condenser required) or injuecting the superheated water into a low-pressure chamber with a condenser in series, as described by Mr. McDermet; or by chemical treatment; or by a combination of systems, as is most suitable and convenient. We have had in continuous use for nearly five years a process for removing oxygen by the latter principle. The heated water is passed under pressure through a large mass of expanded steel scrap, which I have termed "deactivating" the water in distinction to mechanical de-aëration. In this way the last trace of oxygen may be removed within a wide range of temperature and pressure.

Mr. McDermet calls attention to the very accelerated corrosion in the steel tank, copper pans and condenser of his experimental apparatus. We have frequently found when using *closed* heaters that about one-half of the corrosion is removed by contact with parts of the heater or connecting pipes, which indicates how very effective is this means for removing dissolved oxygen. Mechanical means for removing free oxygen from water require careful adjustment and control of temperature and pressure, whereas chemical means such as the use of a suitable kind of steel scrap, will "fix" the oxygen independently of such variations without further attention except for the renewal of material at long intervals.

Mr. McDermet's paper shows an interesting method that may be used for mechanical de-aëration of water, but he is hardly justified from the data and experience given in claiming that this process involves a minimum of operating expenses. There seems to be no doubt that the controlling factor in water corrosion is the presence of dissolved oxygen, carbonic acid being of minor importance. The most economical and convenient method for controlling corrosion in steel economizers will be developed by experience, but that control of corrosion can be accomplished by the application of these principles I believe has been established beyond doubt; therefore with attention to the relative temperature of waste gases and feed water so as to avoid outside condensation on tubes, there is no apparent reason why steel economizers cannot be used without any more deterioration than is now experienced in boilers.

Water Level Indicator for Boilers

The ordinary method of checking the water level in a steam boiler by means of test cocks has the disadvantage that with such pressures as are in use the fluid issuing from the cocks, when they are open, is in the form of a jet which is practically the same whether the water level be above, or below, the test cock. Partly in view of this it has long been usual in good practice to fit two water-level gage glasses instead of one. Even so, however, it is possible that the two glasses may be out of action at once, and in some cases it is not always easy to distinguish between a full glass and an empty one. A simple and effective form of water-level indicator which has all the advantages of the test cocks in checking the water level, but does not suffer from their disadvantages, has been patented by Messrs. Cammell Laird & Co., Ltd., and is being manufactured by Messrs. Bromell Patents Company, Ltd., of 64 Darnley St., Glasgow, says *Engineering*. It consists of a metal tube of external diameter and length such that it may replace the glass tube in an ordinary water gage. The metal tube is drilled with a series of small holes about $\frac{1}{32}$ in. in diameter, and at a pitch of a few inches apart.

When this tube is in position on a boiler and the gage cocks are open so that it is put in communication with the water and steam spaces, it is found that the jets which issue from the holes that are below the water level are very distinct in character from those which issue from the holes above the water level. The steam jets issuing above the water level are barely visible and have a very small angle of divergence, while the jets below the water level are in the nature of a distinct white, cloudy spray, and have a wide angle of divergence. It will be clear that this device enables a very close reading of the water level to be obtained with ease and certainty, and that there is nothing in it to go wrong. A hole may be stopped up, but if this happens it is at once evident and may easily be cleared. With the size of the holes used, this minor trouble is not very likely to occur.

It is found that the best contrast between the jets is obtained when the length of the jet passage is equal to its diameter, and to obtain this proportion a flat is filed on the tube at the point where the hole is drilled. It will be evident that these distinctive jets may be obtained by fitting suitable nozzles to ordinary test cocks, but the arrangement would not give the close reading of water level which is obtained with the indicator, unless an unusual and probably undesirable number of test cocks were fitted.

Pension Plan of Ontario Hydro-Electric Commission

In accordance with an act passed by the Ontario Legislature, the Ontario Hydro-Electric Commission has inaugurated for the benefit of its employees a pension plan, an insurance and sick benefit plan and a savings account for women employees.

About 2,500 employees will benefit from these plans. A pension will be paid to any male employee with service of 15 years and who has reached age of sixty-five or who has become permanently disabled before his sixty-fifth birthday. The pension will be an annual payment of one eightieth of the pensioner's average salary for previous 5 years, multiplied by the number of years he has been in the service. There will be no assessment on the employees for any of the benefits.

A savings account will also be opened for each woman employee, in which will be deposited 5 per cent of her salary each year, and the amount thus accrued will be paid to her when she leaves the service.

Reserve Strength of Elevator Ropes*

By W. Voigtlander
Engineering Department, John A. Roebling's Sons Company,
Trenton, New Jersey

THE prime mechanism of the modern elevator is the wire rope, for upon its condition and life more than upon any part of the equipment is the service dependent. I will therefore touch upon the reserve strength of 6 x 19 ropes, inasmuch as there seems to be much doubt as to the strength of ropes having one or more wires broken.

By 6 x 19 ropes we mean six 19-wire strands laid about a hemp center, as shown in the sectional view Fig. 2. The construction of the rope is such that the outside layer consists of alternate large and small wires so as to form a round strand. The upper diagrams show the dissected strand, and in the following discussion of broken wires reference will be made to large outside and small outside wires. Tests made by Roebling's show the reserve strength for various conditions when using new ropes with wires cut. The results of these tests are given in the accompanying table, but only some extreme conditions will be pointed out.

Test 1, having one large wire cut in each of the 6 strands at the same cross-section, resulted in a reduction of both the metallic area and the breaking strength of the rope to approximately 93 per cent of the original.

Test 2, having one large and one small wire cut in each of the 6 strands at the same cross-section resulted in 89½ per cent of original area and 90½ per cent of original strength.

Test 4, two large wires and two small wires similarly cut in each of the 6 strands, resulted in 79¼ per cent area and 83⅜ per cent strength.

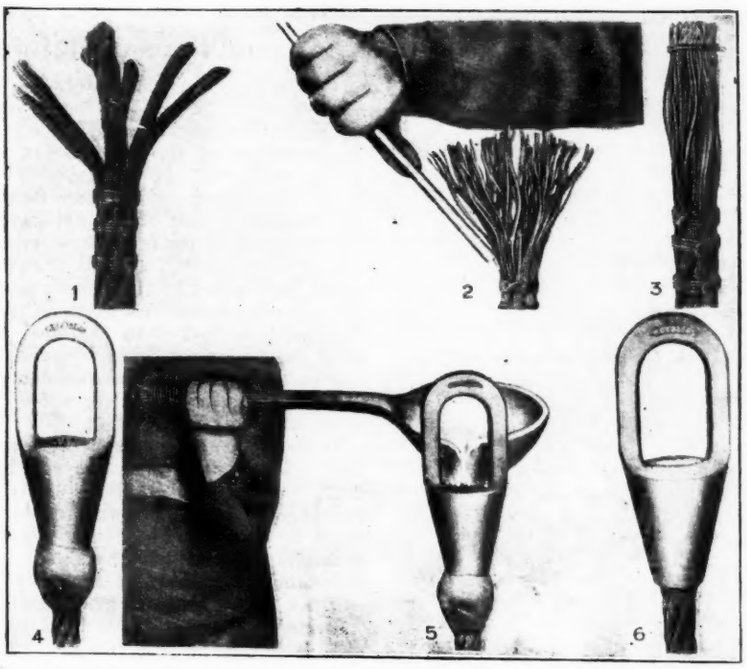
Test 8, all twelve outside wires cut in only one strand, resulted in 89½ per cent area and 75 per cent strength.

Test 1. One large wire cut from each strand. Each wire cut three times. End cuts a distance of two rope lays from center cut. Each series of cuts in same circumference.

Test 2. One large and one small wire cut in each strand on same axis. Each wire cut three times. End cuts a distance of one rope lay from center cut.

Test 3. Two large wires and one small wire cut in each strand in same manner as in test 2.

Test 4. Two large and two small wires cut in each strand, same manner as in test 2.



The Correct Method of Socketing Wire Rope

1. Measure from end of rope a length equal to basket of socket. Serve at his point with not less than three wraps. Cut out hemp center, open strands.

2. Separate wires in strands, straighten by means of iron pipe, cleanse with kerosene oil, wipe dry.

3. Dip wires into one-half muriatic acid, one-half water (use no stronger solution). Keep wires in long enough to be thoroughly cleansed--wipe dry, serve end that socket may slip over all of the wires.

4. After placing on socket, cut serving wire at top—have all wires evenly distributed and even with top of basket—place fire clay around bottom of socket.

5. Pour in molten pure zinc—do not use babbitt.

6. Remove all servings except one nearest socket. After cooling, it is ready for service.

Test 5. Three large and two small wires cut in each strand, same manner as in test 2.

Test 6. Three large and three small wires cut in each strand, same manner as in test 2.

Test 7. Four large and three small wires cut in each strand, same manner as in test 2.

Test 8. Three sets of four wires each or all outside wires in one strand only cut. Wires cut only once. Each set of four wires cut were a distance of one strand lay from each other.

Test 9. Same as test 7, except each wire cut only once.

Test 10. Same as test 8, except two strands were cut.

Test 11. Four large wires and three small outside wires in each strand cut. One large wire in each strand cut in center in same circumference. One end cut, two large and one small wires; other end cut two small and one large. Distance from center to end cuts one strand lay. Each wire cut only once.

Test 12. Same as test 10, except that each set of cuts was a distance of one rope lay apart.

Test 13. Same as test 8, except that each set of cuts was a distance of one rope lay apart.

The examples given are sufficient to point out that, where the broken wires are uniformly distributed in all six strands, the reserve strength is greater in proportion than the net metallic area. It has been demonstrated by us in tests that where every outside wire of all the six strands have been cut, the reserve strength is 42 per cent, whereas the net metallic area is 37.6 per cent.

It is seen from test 8 and also shown in test 10 that where all the cut wires occur in only one strand, the re-

*Paper presented before the American Society of Safety Engineers and published in *Safety Engineering*.

serve strength is less in proportion than the net metallic area. This is due to the fact that the strand that is thus cut, collapses to a degree that allows the other five strands to change their relative positions and thereby reduces the original efficiency of the rope construction.

It is therefore of the utmost importance that any condition that causes one strand in any of the ropes on an elevator to wear more than other strands should be bettered or as much as possible done away with. The chief causes for this condition of one strand wear are improper socketing, unequal tensions in the ropes supporting the car and worn grooves in the drum and idlers.

It has been conclusively demonstrated by repeated tests that the most efficient socket attachment is made by a "straight wire brush" held in the conical basket of the

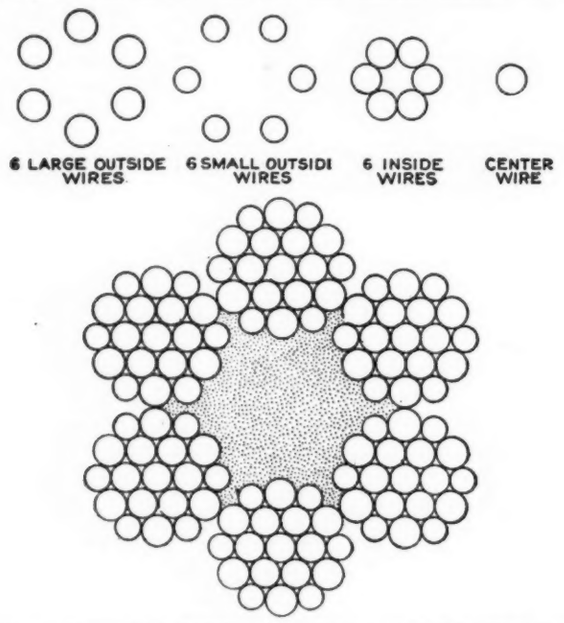


FIG. 2. REGULAR CONSTRUCTION 6 x 19 ELEVATOR ROPE

socket by means of spelter (pure zinc). The proper method of socketing is shown on the accompanying plate. To bend the wires back not only reduces the efficiency of the connection, but has proved to have pushed back one or more strands, causing "high strands." These "high strands" are thus the first to wear and cause more rapid failure, as already pointed out. To use other metal than zinc will prove less efficient—perhaps not in a test sample in the testing

TESTS OF 6 x 19 ROPES SHOWING RESERVE STRENGTH

Test No.	Number of Strands Cut	Number of Outside Wires Cut in a Strand Large	Small	Percentage of Metal Area	Percentage of Original Strength
1	6	1		93.02	92.60
2	6	1	1	89.56	90.46
3	6	2	1	82.62	84.50
4	6	2	2	79.20	83.74
5	6	3	2	72.23	77.51
6	6	3	3	68.79	74.51
7	6	4	3	61.83	69.45
8	1	6	6	89.56	75.09
9	6	4	3	61.83	72.71
10	2	6	6	79.20	67.60
11	6	4	3	61.83	73.54
12	2	6	6	79.20	90.29
13	1	6	6	89.56	95.85

machine, but in a long-endured load at only the working tension. This refers principally to the use of babbitt, solder, lead and other low-melting alloys.

Unequal tensions of the ropes cause rope failure shown in broken wires due to fatigue. Though the estimated factor of safety for a set of ropes may be 8 or 10, it has been shown that where, by unequal tensions, one rope may be carrying twice or even greater proportion of its supposed load, the combined load and bending stresses have so fatigued the steel that the wires break prematurely. The unequal tension also accentuates any faulty condition in socketing as well as placing more load on one groove or more of the multiple-grooved drum and idlers.

Worn grooves cause rope wear due to excessive slippage, of which one instance will serve as an example. In a 2 to 1 traction machine one of the grooves on the drum was found to be $\frac{3}{32}$ in. below the level of the others, which would result in approximately $\frac{3}{16}$ in. reduction in circumference. The extreme points of travel resulted in 27 revolutions of the drum, which caused the one rope to slip five inches more than the others in each travel up or down. A groove worn down by an old rope will pinch a new rope, and this causes short life for replacement ropes, and the ropes are usually blamed as inferior in workmanship or quality.

Interstate Commerce Commission to Act on Transportation Problems

Continuance of the Interstate Commerce Commission's service order No. 7 may be expected. This conclusion is based on the questions asked and the general attitude of the members of the Commission who heard the argument in the matter of the supply, exchange, interchange and return of open-top equipment. Representatives of the building industries and of the various activities connected with the building of roads made strenuous pleas for the modification of the order, so that a portion of the open-top cars could be allotted to their more necessary uses. The public utility representatives declared it to be their firm belief that nothing less than assigned cars at the mines would meet their requirements. The coal operators contended that the order should not be modified. If the mines are given 100 per cent car supply for a few weeks, they asserted, the acute shortage will be met.

It was charged that contracts are being disregarded and coal sold at high prices in the open market. Since coal costs can be passed along easily in the so-called luxury manufacture, those concerns could afford to pay nearly any price in order to keep their plants in operation. It was pointed out that in other industries coal forms a much more important part of costs, and in such cases as public utilities the increase in price cannot be passed along.

Recommendations made by Lemuel F. Owen of the Chicago Building Material Exchange, representing the Building Material dealers of Chicago and Cook County to the Interstate Commerce Commission provide for an increase in the per diem rental charge on all open and closed cars, as between roads from ninety cents to two dollars per day; to prohibit the reconsignment of all cars and to establish a demurrage charge based on the value of the commodity, or the freight rate, instead of the now prevailing per diem demurrage, irrespective of the commodities contained in the car.

If, within a reasonable length of time, the enforcement of the foregoing fails to provide relief for the existing conditions, it is recommended that at a reasonably later date an order should be made effective limiting the furnishing of all cars for the transportation of any and all commodities excepting the absolute essentials—food, fuel, clothing, shelter and highways.

In an address before the National Association of Window Glass Manufacturers at Atlantic City, Commissioner Colver said: "I hope that when the United States buys $200,000,000 of new equipment for the railroads that equipment will not be used that way. I hope cars will be charged to the road on whose tracks they go at a fair but stiff rental for each day. I hope that a higher demurrage charge, mounting swiftly to severe penalties, will compel the shipper to load and unload with all speed. I hope reconsignment will be limited strictly to its use and that its abuse will be made impossible. As a single instance of such abuse I hear of 100 cars of coal held on sidings near a coal-hungry city and awaiting reconsignment to the highest bidder."

The Westinghouse Electric and Manufacturing Co. is to be congratulated upon the appearance of a book of Western views beautifully illustrated and bound, which formed that company's contribution to the recent National Electric Light Association Convention at Pasadena, Cal.

Soft-Coal Shortage Acute

How the country has run down in its stock of soft coal is strikingly shown in a report just issued by the Geological Survey. These official figures, embracing every state in the Union, show that huge industrial and utility plants of the nation have been going along during the last few months with an average of from one to two weeks' supply of coal.

While in ordinary times there is a supply of some 35,000,000 tons of coal in the country's bins in the early spring months the country's surplus throughout last spring was almost entirely exhausted.

On May 31, the Survey's figures show, there were stocks of bituminous coal at industrial plants, other than steel, of 3,389,066 tons throughout the country, representing an average of 3¾ weeks' supply. Public utility plants had on hand 1,372,880 tons, or a little over 3 weeks' supply. Coal-gas plants had stocks of 222,805 tons, or enough to last 3½ weeks. In some centers the shortage was much more acute than in others.

With an increasing demand for coal throughout the country and lessened production because of car shortage, the average of stocks in the hands of manufacturing plants, public utilities and other large consumers throughout the country gradually diminished during June. Unofficial reports show that many of the manufacturing plants by that time had run down to a supply that would last only a little over a week.

Inability of coal operators to get anywhere near an adequate supply of cars to take coal from the mines is brought out by the Geological Survey. Reports embraced in the Survey's statement from some 3,000 mines, representing approximately 60 per cent of the aggregate soft-coal capacity of the country, show that there was an average of 43⅗ per cent of potential production lost through shortage of coal cars, for the entire country. In some of the fields, notably West Virginia, Kentucky and Illinois, the loss of production due to shortage of cars ran from 50 per cent and up to 65 per cent of normal.

New England States Association, N. A. S. E. Convention

The annual convention of the New England States Association of the N. A. S. E. combined with the Mechanical Exhibit of the New England Association of Commercial Engineers was held at Worcester, Mass., July 7-10. The Bancroft Hotel was the headquarters.

There were upwards of seventy-five delegates in attendance. Among the visiters were numbered National President John J. Callahan and many past presidents, also a big delegation of prominent members of the organization from the New England States and elsewhere.

The Casino, situated in close proximity to the headquarters, was arranged for the use of the supplymen in the display of their wares. Booths were occupied by 105 firms exhibiting mainly new devices in the engineering field, the whole making a most attractive display, which was liberally patronized during the four days.

The exhibit at the Casino was formally opened on Wednesday evening. Harry H. Atkinson, president of the New England Association of Commercial Engineers, presided and introduced the following speakers, who made short addresses: Hon. Channing H. Cox, lieutenant governor of Massachusetts; Major James Myrick, treasurer of the supplymen; Robert Johnson, chairman of the local committee; Charles E. Hildreth, president of the Chamber of Commerce, and Tremont E. Eggleston, Jr., chairman of the exhibition committee. The exhibition was open from 10 a.m. to 10:30 p.m.

The opening exercises of the engineers were held in the banquet hall of the Bancroft Hotel on Thursday evening. The meeting was called to order by Chairman Robert Johnson, who introduced Herbert E. Stone, master of ceremonies. Alderman Joseph W. Leydon welcomed the convention to Worcester in place of Mayor Sullivan, who was called from the city. Warren H. Goodrich responded and spoke of the growth of the N. A. S. E. during the past year. Charles E. Hildreth, president of the Worcester Chamber of Commerce, told of the dignity of the engineering profession and expressed how pleased the citizens of the city were to have the delegates and visitors among them. He said that the engineer was undoubtedly the mainspring of civilization. Charles C. Gardiner, chairman of the Educational Committee, of Taunton, spoke of the help that the members of the N. A. S. E. have always given to the Government in the time of need and hoped that the members in Worcester and other cities would get in closer relation with the Chamber of Commerce, as much good could be accomplished in this way. Dr. Ira N. Hollis, president of the Worcester Polytechnic Institute, advised strict economy and frugality on the part of the engineers. He urged the necessity for internal peace in our own country. If this could be brought about there would be absolutely no fear of friction with outsiders. He said that happiness never comes in the pursuit of happiness, but in the pursuit of work; that man is happiest who is doing some interesting work for someone else. Vice President Elmer L. Dean responded for the engineers, and the ceremonies closed with the singing of the National Anthem.

On Friday evening a smoker was given in the banquet hall of the hotel. This event was well attended and an enjoyable program of entertainment was given by members of the Supplymen's Association and some local talent.

The outing at Lake Park on Saturday afternoon was a big success. Autos conveyed the company to the grounds where outdoor sports of all kinds were indulged in, with prizes to the winners. The baseball game resulted in a tie. The festivities ended with an appetizing sheep bake at the Winchester Boat House.

The election of officers of the delegates resulted as follows: Dudley S. Kimball, president, Cambridge; George C. Madison, vice president, Worcester; Freeman L. Tyler, secretary, Taunton; Walter H. Damon, treasurer, Springfield; John H. Graham, conductor, Fall River; Thomas Livingston, doorkeeper, Meriden.

The New England Association of Commercial Engineers elected officers as follows: Harry H. Atkinson, president, Economy Lubricating Co.; S. E. Smith, vice president, McClave-Brooks Co.; Maj. James W. Myrick, treasurer, Auto Force Ventilating Co. The three trustees elected to serve three years were: F. S. Eggleston, Eggleston Supply Co.; L. W. Merrihew, Strong, Carlisle & Hammond Co.; Fred M. Couch, V. D. Anderson Co.

The presentations were a past president's badge and diamond stickpin to Warren Goodrich, gold watch and chain to Harry Atkinson and a magnifying glass to Walter Damon.

N. A. S. E. MEMBERS AND DELEGATES PRESENT AT CONVENTION

Charges Anthracite Industry Is Controlled by a System

W. Jett Lauck, in arguing the admissibility of exhibits on profiteering and monopoly which he had submitted in behalf of the United Mine Workers of America and to which the representatives of the operators had interposed objections, declared that the real profits of the anthracite industry were at least seven times the apparent profits and charged that the anthracite coal industry is dominated by a monopolistic system that is squeezing both the consumer and the wage earner by diverting profits at points where neither can see through the screen of legal devices and bookkeeping.

Mr. Lauck contended that there is no warrant for the assertion that the anthracite industry cannot pay higher wages without a further increase in the price charged to the consumer. The anthracite industry is paying profits that are amply adequate to absorb the cost of a just increase in wages.

"Enough money is abstracted between the time when the coal leaves the mine and the time when it reaches the local dealer to pay the requested wage increase and at the same time to reduce the price of the anthracite to the consumer," said Mr. Lauck.

The anthracite industry is similar in structure to an octopus. Its head and body are a very small group of banking interests. Its arms are seven railway systems which control at their extremities the anthracite mining operations of the country.

The books of the entire concern represented by the seven great business organizations must be examined before anyone can say just what the profits are.

Mr. Lauck declared that such an examination of the books was necessary for the settlement of the controversy and that the bookkeeping evidences of the unity between the railroads and their coal companies was overwhelming. Such high rates for the transportation of anthracite were established by the railroad companies that it became impossible for a coal company to operate at a profit. The railroad coal companies were then supported by subsidies granted in one form or another by the parent railroad company. This was made possible by a bookkeeping system that rendered the finances of the two companies practically one.

In the rush to monopolize anthracite reserves, the railroad companies purchased thousands of acres of unproductive land for which the consumers and mine workers are being asked to pay by high prices and a non-living wage.

The point which Mr. Lauck emphasizes and brings out is that a well-defined process exists by which the profits of the anthracite industry are successfully concealed, the high prices being explained by apparent high costs. The losses of the railroad companies are written into the cost of transportation through advances without interest and through the funding operations which impose large fixed charges upon the railroad department. The high freight rates which such inflated transportation costs seem to justify are written into the cost of anthracite and serve to bridge the gap between the mine cost and the high prices which prevail.

Engineer Officer on Water-Power Commission

Another step in the organization of the Federal Power Commission was taken July 8, when the President designated Lieut. Col. William Kelly as its Engineer Officer.

Much of Colonel Kelly's experience has been in California on engineering projects which brought him in close contact with the water-power situation. He was graduated from the United States Military Academy in 1899. He trained the 117th Engineers and took that regiment to France in 1917. Later, he became Chief Engineer for the Fourth Army Corps. From that post he was promoted to Base Commanding Officer. He is now engaged in river and harbor work at San Francisco.

Engineering Foundation and an American Hydraulic Laboratory

Certain engineers have recently proposed an endowed American Hydraulic Laboratory. There are many needed contributions to hydraulic engineering and the underlying science which can best be made by a laboratory with sufficient resources.

In Engineering Foundation there exists the instrumentality for bringing into existence such a laboratory as is suggested. Engineering Foundation Board is thoroughly competent to receive and administer endowment funds in any amount, including those which might be especially designated for an American Hydraulic Laboratory.

Instead of creating a new laboratory, it might be found advisable for Engineering Foundation, if funds should be provided, to serve as an American Hydraulic Institute. The institute could enlarge the usefulness of the existing hydraulic laboratories of the universities, the Government and the industries by directing experimenters and allocating problems to the laboratory best equipped for each specific project undertaken. It could contribute to the support of the experimenter and, if existing facilities were not adequate, could improve the facilities in the laboratory selected for the work.

The Water Power Commission Begins Organizing

Regulations governing the administration of the Water-Power Act are to be drafted by a committee consisting of Oscar C. Merrill, Gen. Enoch H. Crowder and Herman Stabler. Two or three months will be required to draft the regulations, it is believed.

The first official act of Mr. Merrill, as secretary of the Federal Power Commission, was to present formally to the Solicitor of the Treasury the questions pertaining to the employment of the personnel of the commission. Due to an oversight, the act does not provide any specific authority for the employment of specialists, clerks or assistants of any kind.

The wording of the act in several places makes it very clear, however, that it was the intention of Congress for the commission to employ the necessary personnel. If the solicitor should find that no authority for employment is given, the work of the commission will be considerably hampered, as it will have to depend entirely upon such help as can be loaned by the War, Interior and Agriculture Departments.

Major Max C. Tyler has been selected by Gen. Lansing H. Beach, the chief of engineers, to make the report on the Great Falls power project, which was authorized by the act.

Advisory Board for Power Survey

Prof. L. P. Breckenridge, head of the department of Mechanical Engineering of Yale University, has been appointed chairman of the advisory board which will play an important part in the power survey of the North Atlantic seaboard between Boston and Washington. He will work in close co-operation with William S. Murray, the chairman of the engineering staff which will be engaged on this work. Professor Breckenridge will represent fuel engineering on the board.

The full membership of the board has not been selected, as yet. E. G. Buckland, vice president of the New York, New Haven & Hartford R.R., has accepted an appointment to the board, as has James H. McGraw, president of the McGraw-Hill Co., Inc. Among other members of the board, yet to be designated, are representatives of the National Electric Light Association and the American Electric Railway Association.

The super-power survey is to be directed from New York City, where the United States Geological Survey just has opened offices in the Buckley-Newhall Building, 709 Sixth Avenue.

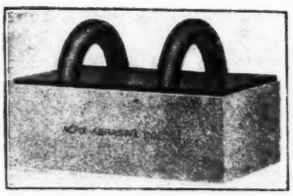
Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Stone, Acme Commutator Smoothing

Green Equipment Corporation, Monadnock Block, Chicago, Ill.

"Power." 1920



This stone possesses high insulating quality and when held against the surface of a commutator or collector ring while a machine is in motion will smooth down the uneven surfaces. The cutting down is done with one grade of stone and the finishing surface is made with another of finer texture. Although the stone is made with a flat surface its contour, due to wastage, will really conform to the convex shape of the commutator that is being treated.

Wrench, Adjustable Ratchet

Allan-Diffenbaugh Wrench and Tool Co., 6250 South Halsted St., Chicago, Ill.

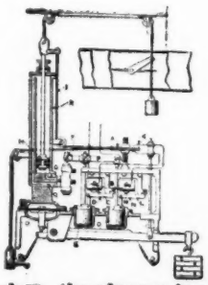
"Power," 1920

A self-adjusting wrench that will take the place of several sizes of open-end wrenches. To operate, simply place the jaws over the nut and pull on the handle—the harder the pull the harder the jaws will grip. To let go of the nut, simply release the handle, which releases the grip of the jaws and permits a ratchet action on the nut.

Regulator, R. K. Hydro-Electric Pressure

Ruggles-Klingemann Manufacturing Co., Salem, Mass.

"Power," June 1, 1920



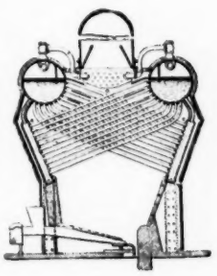
This special regulator is designed to eliminate all erratic action in operation. The scale beam is free to respond accurately to variations in pressure of ¼ lb. or less and to transmit its readings by means of electric contact to limit the movement of the motor plunger. The variations in pressure are transmitted to a pilot valve which controls the movement of the motor by means of electric magnets. One magnet controls the upward movement of the plunger and another the downward movement, the pilot valve normally being held in a neutral position where no pressure can be transmitted to the motor or cylinder. The motor travels by stages. The plunger is moved step by step with a well-designed period of rest between stages of its travel. When a change of pressure takes place, the plunger is moved rapidly to the next succeeding stage and comes to rest and so remains until the pressure changes.

Boiler, Burton Duplex Water-Tube

De Pere-Burton Co., De Pere, Wis.

"Power," May 11, 1920

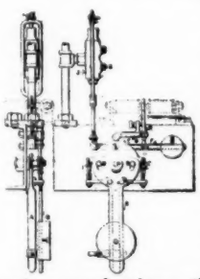
This is a one pass boiler, provided with two cross-drums at opposite ends of the setting. The tubes lead obliquely upward across the path of the gases and enter their respective drums. A vertical row of tubes lead from the water leg at one side of the boiler and enter the drum at the other side. The next row of tubes connect the water leg at the right-hand side of the setting and the drum at the opposite side. Thus the rows of tubes alternate in the direction of their slope and cross over the combustion chamber. Most of the tubes are curved at one end. The tubes may be cleaned from within the drum, and instead of pulling them out through hand holes in the header they may be removed into the combustion chamber. Key caps are provided in the water leg opposite each tube.



Speed Limit, Clock-Pendulum Precision

E. E. Clock, Fidelity & Casualty Co., of New York, N. Y.

"Power," June 1, 1920

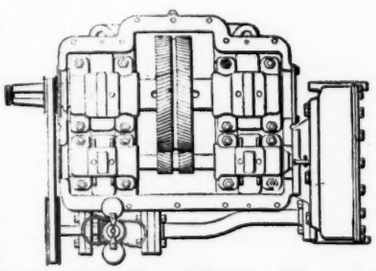


This is a device for the control of steam engines and is connected to any reciprocating part of the engine. There are two pendulums, one being positively driven and moved through a fixed arc; the other, or weighted pendulum, is in line and swings with the positively driven arc until such time as the operation becomes fast enough to overcome the stabilizing spring, which tends to hold the weight pendulum firmly on two pins that project through the curved slots in the disk attached to the weight pendulum. As the positive driven pendulum moves to the right and starts upon the return stroke faster than that for which it is adjusted, a contact is made with electrical apparatus and by moving a lever and by working of the various mechanisms, the pilot valve is opened, resulting in a flow of water through the connection to the operating cylinder. This unlatches the automatic throttle valve and gives it a start, and the throttle sleeve being released together with the piston effect of the steam valve stem closes the throttle promptly.

Transmission Turbine Gear

B. F. Sturtevant Co., Boston, Mass.

"Power," June 8, 1920

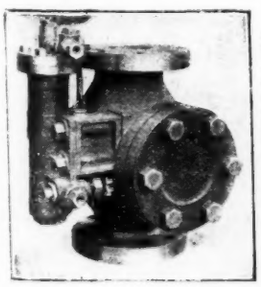


This turbo-transmission is designed for shaft and pump drive. It is self-contained and does away with turbine bearings and turbine packing. The turbine and pinion shaft is supported by two bearings in the gear casing, but the turbine proper overhangs the gear casing at one end. Two pinions are carried on the turbine shaft, and these connect with two large gears which are carried on the gear shaft and couple to the shaft or pump that is to be driven. It is built in two sizes, 25 and 50 hp. The speed is controlled by a throttling governor driven from the gear shaft.

Regulator, Framanco Pump

Edward Valve and Manufacturing Co., Chicago, Ill.

"Power," May 25, 1920

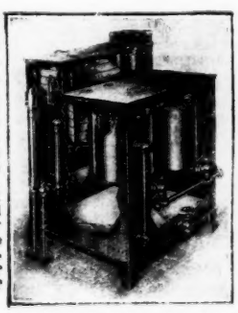


This pump regulator is designed to maintain a constant differential between the discharge pressure and the steam pressure, or a fixed pressure at the delivery end of the pump. One of the distinguishing features is the separation of the valve proper and the control cylinder, thus eliminating expansion and contraction troubles due to the high temperature of the steam. The regulator will operate either in a horizontal line or in any other position. It is said that with a normal pressure of 175 lb., an increase of less than 5 lb. will close the valve and stop the pump, or a decrease of 3 lb. will cause the valve to open in full.

Filter, New Wayne Gravity Oil

Wayne Oil Tank and Pump Co., Fort Wayne, Ind.

"Power," June 15, 1920



This filter handles continuously large volumes of oil. The water and much of the sediment are removed by a tray system, thus reducing the work of the filtering medium. Dirty oil passes through a screen to a heating compartment, then through a precipitating chamber and from there to filtering units from which it goes to the clean-oil compartment. The screen removes impurities from the oil and much of the remaining impurities are gathered and deposited on the trays. Water is separated from the oil as it passes over the heating coils. The final filtering is done by means of cloth filter units which remove the remaining slime and impurities that have not been precipitated. This type of filter is built for capacities ranging from 2 to 600 gal. per hour.

Patented Aug. 20, 1918

New Publications

EFFICIENT BOILER MANAGEMENT. By Charles F. Wade. Published by Longmans, Green & Co., London and New York. Cloth; 6 x 9 in.; 266 pages. Price $4.50.

The author, who has had considerable experience in this field abroad, aims to bridge the gap between the scientific discussion of chemistry, fuel analysis, etc., and the purely descriptive articles and pamphlets dealing with steam-making apparatus. The elementary scientific principles underlying the various subjects are taken up in the usual sequence. The treatment is pleasing and of utility value. In the way of illustrations the author has provided many, and while many, if not most of them, are catalog reproductions, the selection is good. The reader will be disappointed with the meagre text devoted to mechanical stokers and furnaces suited to various stokers and fuels. Perhaps the author is not to be criticized inasmuch as mechanical stokers of the multiple-retort type are not nearly so common in the British Isles as in America it is presumed that he wrote for the English reader chiefly. In the United States engineers will want to follow the test code of the American Society of Mechanical Engineers instead of the forms given by the author; they are similar of course, but in view of the value of standard methods in testing reporting and comparing them the American Society's code should be used here. As efficient boiler room management these days is so much influenced by design and general arrangement of boiler house and equipment, the American engineer will be disappointed to find that the author has barely touched on this important subject so interrelated with management.

Obituary

O. C. Woolsen, mechanical engineer, with offices in Newark and New York City, died at his home, 80 Broad St., Newark, N. J., on July 2, following a lingering illness. Mr. Woolsen contracted a cold which developed an asthmatic condition, causing his death. The news came as a shock to his many business acquaintances and friends both in Newark and New York. Mr. Woolsen was well known in engineering circles and for many years was a member of the American Society of Mechanical Engineers, the Newark Board of Trade and the New York Railroad Club. He is survived by two daughters, Helen Woolsen and Mrs. Charles Weigand, of Newark, and a son, O. C. Woolsen, Jr., who, at the time of his father's death, was at St. Paul, Minnesota.

Personals

S. H. Cleland has been appointed Eastern sales manager of the National Engineering Co., Chicago. He has opened temporary offices at 15 East Fortieth St., New York City.

H. F. Strickland has resigned as chief engineer of the Hydro-Electric Power Commission of Ontario. Mr. Strickland was connected with the commission for eight years.

Alexander Wilson, formerly chief electrical engineer of the Montreal Light, Heat and Power Co., has opened an office as consulting engineer in the Yorkshire Building, Montreal, Quebec.

W. C. Rott, formerly with several large steel companies, has joined the staff of Barton R. Shover, consulting electrical, iron and steel plant, and steam engineer, Oliver Building, Pittsburgh, Pa.

George M. Wisner, for the past thirteen years chief engineer of the sanitary district of Chicago, has resigned to enter business for himself. Mr. Wisner will continue to act as consulting engineer for the district board.

Prof. C. C. Williams, of the School of Engineering at the University of Kansas, will go to Europe this summer to study transportation problems there. He will visit England, Holland, France, Belgium, Italy and Switzerland.

Edwin A. Rogers has resigned his position as power-plant engineer of the New Cornelia Copper Co., Ajo, Ariz., and has opened an office as consulting engineer, in San Francisco, Cal., specializing in fuel-oil combustion and power-plant efficiency work.

Edward Blakeny, formerly in the engineering department of the American Telephone and Telegraph Co. and the Western Union Telegraph Co., is now a member of the technical staff of the research department of the Radio Corporation of America, New York City.

George P. Sonn, formerly with the National Conduit and Cable Co., Inc., and the National Brass and Copper Tube Co., Inc., as mechanical engineer, is now with the Machine Tool Engineering Co., Inc., Singer Building, New York City, as special sales representative.

Dr. C. O. Mailloux, past president of the American Institute of Electrical Engineers and president of the International Electrotechnical Commission, has been made an honorary member of the Société Français des Electriciens, the leading electrical society of France.

J. W. Dorsey, assistant professor of electrical engineering at the University of Manitoba, has incorporated a company under the name of the Dorsey Electrical Laboratories, Ltd. Professor Dorsey announced a few nights ago that he had discovered a new and cheaper way of transmitting electrical power.

Sam W. Smith, for many years sales manager of the Uehling Instrument Co., of New York, and formerly equipment engineer for the Southern New England Telephone Co., has joined the Smith Engineering and Supply Co., Boston. This concern will represent the Uehling Instrument Co. and the Adriance Bate Co., makers of the Bate flue cleaners, in New England.

Edward J. Cheney, secretary of the Standards Committee of the American Institute of Electrical Engineers, formerly connected with the General Electric Co. and recently chief of the Division of Light, Heat and Power of the Public Service Commission, Second District, Albany, N. Y., has opened an office at 61 Broadway, New York City, for a general engineering and consulting practice.

Society Affairs

The American Peat Society will hold its annual meeting at Madison, Wis., Sept. 2-4. A number of interesting papers will be presented at the meeting. A definite program has not been prepared as yet.

The Association of Iron and Steel Electrical Engineers will hold its fourteenth annual convention at the Hotel Pennsylvania, New York City, Sept. 20-24. The program, as a whole, deals with the complete plant electrification from the ore pile to the finished product. A feature of the convention will be the display of the products of the representative electrical manufacturers.

The New York Section of the American Institute of Electrical Engineers is planning a series of joint meetings throughout the coming year with the Metropolitan Section of the American Society of Mechanical Engineers. Among the subjects selected for discussion at the meetings are marine engineering, enginering education, industrial installation, power generation, steam-railroad electrification and industrial relations. The first meeting will be held in October.

The National Electric Light Association has been invited to appoint a representative to serve on an advisory board which will co-operate with the engineering staff of the North Atlantic Seaboard Super Power Survey. L. P. Breckenridge, professor of mechanical engineering at Yale University, will head the Advisory Board and also represent the fuel-engineering profession. Other members of the Board already appointed are James H. McGraw, president of the McGraw-Hill Publishing Co., and E. G. Buckland, vice president New York, New Haven & Hartford Railroad.

Business Items

The Mexico (Mo.) Power Co. has purchased the municipal plant at Wellsville and is now furnishing current from the central plant in Mexico to that city.

The Adirondack Power and Light Corp. is planning to construct a steam-power plant in the Mohawk Valley, as an auxiliary to its various water-power plants. The new plant, it is expected, will be located near Amsterdam, where several sites have been investigated.

The Southern Sierras Power Co., San Bernardino, Cal., is planning a $250,000 improvement to its steam plant. Work will begin at once. The improvement is an additional "frequency change" to be installed by the Southern Sierras and Southern California Edison Co. jointly.

The Tonawanda Power Co., North Tonawanda, N. Y., has started work on the construction of an addition to its transformer station, which will give the company equipment for the transmission of twice as much power as at present for industrial and lighting purposes.

The West Penn Power Co. has obtained possession of ten Pennsylvania corporations licensed to operate in Greene County. These concerns are: Mt. Morris Power Co., Aleppo Power Co., Center Power Co., Gilmore Power Co., Graysville Power Co., Jackson Power Co., Morris Power Co., Springfield Power Co., and the Wayne Power Co.

Trade Catalogs

Girtanner Standardized Steam Ash Conveyor is the title of a new 13-page catalog now ready for distribution by the Girtanner Engineering Corp., of New York. Illustrations and descriptions of the Girtanner line of ash conveyors are given. A copy of the catalog will be sent on request.

The Gas Combustion Co., Union Arcade, Pittsburgh, Pa., has ready for distribution a new 24-page catalog entitled "The Bradshaw Burner." Descriptions of the various types of burners are given, including standard and pressure types for boilers, standard types for stoves and standard pressure types for gas producers. An analysis of combustion chamber, stack and gas pressures is also contained in the catalog. A copy will be sent on request.

The Crescent Belt Fastener Co., of New York, has ready for distribution a new 6-page pamphlet, Form N. Y. 227, dealing with belt joints. A service chart which will enable the customer to determine the size of Crescent plates and rivets adapted to his use for any condition of work is given. Full description of the method of making joints is also outlined. A copy of the pamphlet can be obtained on request.

The Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., has published a new catalog 4-A-1, giving a complete list of distribution transformers with list prices. Distributed-shell, rectangular-core, and simple-shell construction with auxiliary apparatus has been outlined clearly. Single-phase, 25- and 60-cycle and three-phase 60-cycle transformers oil-insulated and self-cooled, with their voltage ratings, have been listed. The standardization of distribution transformers by various associations is discussed.

The Portable Machinery Co. of Passaic, N. J., has published a new 24-page catalog entitled "Portable Conveyors." By a number of illustrations the scoop conveyor handled by this company is shown in actual operation. The conveyor described in the booklet is designed to be moved and operated by one man. Its distinctive feature is the "feed end," which can be pushed and completely buried in the material to be conveyed, thus allowing the material to be scraped into the carrying belt instead of being lifted by shovel into a feed hopper. A copy will be sent on request.

The Metal and Thermit Corporation, New York, N. Y., has just issued the Third Edition of its Thermit Pipe Welding Pamphlet No. 16. In this new edition the subject of Thermit pipe welding has been revised and brought up to date. The new pamphlet describes and illustrates in detail how Thermit pipe welds are made and contains reports on successful tensile strength and vibration tests of Thermit pipe welds conducted by Stevens Institute. One of the features of the new pamphlet, not previously published in former editions, is a chart showing the comparatively low cost of a Thermit welded pipe as compared with the cost of installing compression flanges with bolts and gaskets, and of installing elbows with flanged connections.

Coal Situation No Better—No Worse

No reduction in prices of bituminous coal in the eastern states. Investigation under way in Baltimore. Car shortage still the prime factor in Illinois' high prices. Diversion of fuel to Michigan disturbs Midwest market. Desperate coal situation in Milwaukee leads to the appointment of a commission to appeal to the I. C. C.

The larger coal consumers in Boston have 30-days' supply according to a careful survey. In several industrial centers stocks have increased during the month, apparently owing to reduced consumption. The demand remains strong nevertheless and producers are in a position to exact high prices. Last week $12 and upward was paid for coal at first hand, these prices being f.o.b. mines in central Pennsylvania for July shipment.

New York—Comparatively little coal is being moved from the local docks for local consumption except on permit for use by a public utility corporation. The bituminous demand is lighter but the average price remains the same as last week, i.e., $14 to $15 at the piers with a couple of dollars added for loaded bottoms.

In spite of holiday curtailments in production and shipment, the anthracite situation is easier. The resumption of the regular towing service from Perth Amboy and a betterment in towing conditions in some of the other ports has brought more coal into the city. There has also been an improvement in the railway service and an increased car supply, resulting from the Interstate Commerce Commission order. The steam sizes are slightly easier. Current quotations for company coal per gross ton at the mines and f.o.b. Tidewater, lower ports, are as follows:

	Mine.	Tidewater.
Buckwheat	$4.00@$4.10	$5.75@$5.85
Rice	3.00@ 3.50	4.75@ 5.25
Barley	2.25@ 2.50	4.00@ 4.25
Boiler	2.50	4.25

Philadelphia—Despite the lifting of embargoes, receipts have not increased appreciably. A number of plants have curtailed production, which has eased the market considerably. Price variations are wide and there is hardly a market figure. Bituminous prices range from $10.50 to $12.50 for Pennsylvania coals, while Fairmont grades have been subject to greater variations, with quotations running from $8.50 to $12.75, a good average being $11.75.

The steam sizes of anthracite are in a fairly satisfactory position from the standpoint of coal men. High bituminous prices have increased the anthracite demand until buckwheat is difficult to obtain. Consumers with contracts are stocking up for winter.

Baltimore—Federal investigators from the Department of Justice are now in Baltimore asking questions of shippers and agents of bituminous. It is reported that the coal trade does not regard the investigation very seriously. Customers seem willing to accept coal at high prices, so that the operator does not have to quote, but merely asks what the consumer is willing to pay and then accepts the proffer. The market is highly competitive.

Milwaukee—At Senator Lenroot's suggestion a committee was named to go to Washington to appeal to the Interstate Commerce Commission for relief. The commission will be urged to place an embargo on exports. Docks in the northwest hold five million tons less than a year ago and unless reserve stocks can be accumulated before the close of Lake navigation, factories will shut down.

Chicago—The market continues to absorb whatever coal is offered and premiums are being paid for spot. Current prices for spot range from $5.25 to $6.50 f.o.b. mines, on central and northern Illinois coals, with no differential between the price of lump, screenings or mine run. The car shortage has resulted in a considerably stiffened market, even during last week.

St. Louis—All steam sizes of anthracite are in the greatest demand. The local trade has a fair supply, but no storage ahead, outside buyers paying $4.75 to $5.50 for steam and domestic sizes in the Standard field.

Birmingham—There is a bountiful supply of cars on the Southern and Frisco Lines, mines being furnished a 100 per cent supply. On the other hand, production has fallen off even from last week. The shortage of coal is acute throughout Southern territory, and industrial plants, railroads and public utilities have very small stocks. There is practically no spot coal, and in spite of a strong and active demand for domestic and steam grades, little new business can be accepted because of operating difficulties.

New Publications

PROPOSED WORK

N. H., Portsmouth—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will soon receive bids for removing and reconstructing boiler and stokers.

Mass., Boston—The Boston & Maine R.R. Co., North Station, will soon award the contract for a 6 story, 125 x 135 ft. club building including a steam heating system. About $500,000.

Mass., Boston—Mowll & Rand, Archts., 50 Bromfield St., will soon award the contract for converting present store building into a theatre including a steam heating system on Washington and Essex Sts., for the Washington Essex Bldg. Trustees, 723 Scollar Bldg. About $1,500,000.

Mass., Cambridge — Monks & Johnson, Engrs., 99 Chauncey St., Boston, will soon award the contract for a 1 story, 40 x 80 ft. boiler house, etc., for the Carr Fastener Co., 47 Ninth St. About $40,000.

Mass., Cambridge — John C. Spofford, Archt., 36 Bromfield St., Boston, will soon award the contract for a 6 story, 100 x 100 ft. manufacturing building including a steam heating system on Main St., for the Suffolk Engraving & Electrotyping Co., 394 Atlantic Ave., Boston. About $225,000.

Mass., Danvers — The Comn. on Mental Diseases, 36 State House St., Boston, plans to build a 1 story power plant at the State Insane Asylum here. About $250,000. Kindall, Taylor & Co., 93 Federal St., Boston, Archts. and Engrs.

Mass., Northbridge — The Bd. of Sewer Comrs. plan to construct a sewerage system and pumping station for the town. About $142,000. McClintock & Woodfall, 15 Court Sq., Boston, Engrs.

Mass., South Byfield — The Dummer Academy plans to construct a 3 story school building including a steam heating system. About $150,000.

Mass., Taunton—The Municipal Lighting Comn. plans to construct a 1 story electric light plant addition on West Water St.

N. Y., New York—The Andrew Friedman Foundation Home for Men and Women, 206 Bway., plans to build a home including a steam heating system on the Grand Concourse. About $1,500,000. H. A. Jacobs, 320 5th Ave., New York City, and J. H. Friedlander, 681 5th Ave., New York City, Archts.

N. Y., New York—Sommerfeld & Steckler, Archts. and Engrs., 31 Union Sq., will receive bids until August 2 for a 7 story, 50 x 50 ft. factory including a steam heating system, for the Rigaud Perfume Co., 75 Barron St.

N. Y., Warsaw—H. H. Charles is in the market for one 20-hp. portable gas engine with 40 ft. 10 in. belt and heavy well outfit with extra stem and bits.

N. J., New Brunswick—W. B. Wills, Inc., Archt. and Engr., 1181 Myrtle Ave., Brooklyn, plans to build a 1 story theatre including a steam heating system. About $350,000. Owner's name withheld.

Pa., Altoona — The Altoona Gymnasium Comn. will receive bids in August for a 2 story, 80 x 130 ft. gymnasium including a steam heating system, etc., on Lexington Ave. and 9th St. About $200,000. Jallade, Lindsay & Warren, 37 Liberty St., New York City, Archts.

Pa., Philadelphia — The Pennsylvania R.R., Bell Bldg., is in the market for a 220 volt d.c. motor.

D. C., Washington—The Dist. Comrs. will soon receive bids for a 2 story, 300 x 400 ft. psychopathic ward building in connection with the proposed hospital to be known as the Gallinger Hospital. Plans include a central power plant. About $1,500,000.

D. C., Washington — Marsh & Peter, Archts. and Engrs., 522 13th St., will soon award the contract for a 9 story newspaper building addition including a steam heating system for the Star Newspaper Co., 11th St. and Pennsylvania Ave.

Va., Ashland—The Ashland Ice Plant is in the market for one air compressor and one electric motor. C. B. Boschen, Pur. Agt.

Fla., Jacksonville—The Porter Judy Fruit Co., 442 West Bay St., has secured a permit for installing an 18 car capacity cold storage plant at its establishment here. About $40,000. B. W. Anderson, Supt.

Ala., Florence — The Chamber of Commerce plans to build a power plant here on Cypress Creek, for the city.

Ala., Mobile—G. B. Rogers, Archt. and Engr., Van Antwerp Bldg., will soon award the contract for installing a steam heating system in the proposed 15 story, 75 x 150 ft. office building on the Northwest corner of Dauphin and Conception Sts., for the Van Antwerp Drug Co., Van Antwerp Bldg. About $500,000.

Tenn., Smithville — The Corp. of Smithville voted upon $30,000 bonds to construct a transmission line from here to the Great Falls Power Co. at Rock Island.

O., Cleveland—The Bd. Educ., E. 6th St. and Rockwell Ave., plans to build a 1 story junior high school including a steam heating system on Hopkins Ave. W. R. McCormack, Archt.

O., Cleveland — The Citizens Savings & Trust Co., East 9th St. and Euclid Ave., is having plans prepared for a 10 story, 80 x 150 ft. bank and office building including a steam heating system, at East 101st St. and Euclid Ave. About $500,000. Walker & Weeks, 1900 Euclid Ave., Archts.

O., Cleveland—The city received bids for furnishing and installing two 8,000,000 gal. and one 4,000,000 gal. motor driven vertical centrifugal pumps with motors, etc., from Dravo-Doyle Co., Diamond Bank Bldg., Pittsburgh, Pa., $20,730; Joseph Skeldon Eng. Co., 242 Water St., Toledo, $27,620. Noted June 29.

O., Cleveland—The Ohio Athletic Association Co. c/o T. Ferry, 2151 Scranton Rd., plans to build an 8 story commercial and club building including a steam heating system, on Euclid Ave. and East 32nd St. About $400,000.

O., Cleveland—Parish & Bingham, 10600 Madison Ave., will soon award the contract for a 1 story, 20 x 50 ft. boiler plant. Two 250 hp. boilers will be installed in same. About $40,000. Ernest McGeorge, 1000 Euclid Ave., Archt. and Engr.

Ind., Portland—The Portland Oil & Refining Co. plans to build a refinery and is in the market for steam pumps, pipe, etc. H. J. McConoley, Secy. and Treas.

Mich., Detroit—The Bd. Educ., 50 Bway., will soon award the contract for a 2 story, 65 x 104 ft. addition to the Davidson School on Roman and Joseph Campau Aves., $195,000; a 2 story, 77 x 159 ft. school to be known as the George School on Russell and Superior Sts., $230,000; and a 2 story, 105 x 200 ft. school to be known as the Pattengill School on Northfield and Spokane Aves., $330,000. Separate contracts for installing steam heating systems in these schools will be let.

Mich., Port Huron—The City and County of St. Clair, c/o A. E. Stevenson, plans to build a 3 story city hall addition including a steam heating system on Huron Ave. About $320,000.

Mich., St. Clair—The city is having plans prepared for furnishing and installing a 300 hp. engine, 200 kva. direct connected generator, water meter, piping, etc. About $57,755. G. C. Champe, Toledo, O., Engr.

Mich., Wayne—F. L. Forman, Village Clk., will soon award the contract for furnishing and installing a motor driven centrifugal pump with a 1,000,000 gal. per day capacity in connection with the proposed filtration plant here.

Ill., Chicago—The Ajax Forge Co., 2503 Blue Island Ave., is in the market for one 500 ft. per min., 125 lb. pressure, belt drive air compressor.

Ill., Chicago—The Chicago Northern Masonic Association, c/o F. M. Glennon, 626 South State St., had plans prepared for a 2 story, 150 x 150 ft. masonic temple, including a steam heating system on Winthrop Ave. and Argyle St. About $300,000. Hyde & Brown, 8 South Dearborn St., Archts.

Ill., Chicago—Max Goldberg, Harper Theatre, 5236 Harper Ave., is having plans prepared for a 1 story, 135 x 150 ft. addition to the present theatre including a steam heating system. About $350,000. Z. E. Smith, 305 East 55th St., Archt.

Ill., Chicago—Hyde & Brown, Archts., 8 South Dearborn St., will receive bids until August 10 for a 3 story, 125 x 200 ft. masonic temple including a steam heating system on Cottage Grove Ave. and 61st St., for the Midway Masonic Temple Association. About $750,000.

Wis., Stratford—Frank J. Curtin, Village Clk., will soon award the contract for the construction of a well reservoir and an 18 x 30 ft. pumping station and for furnishing a 250 gal. power pump and a 20 hp. gasoline-kerosene engine. W. G. Kirchoffer, Madison, Engr.

Ia., Marshalltown—The C. A. Dunham Co., 343 South Dearborn St., Chicago, plans to build a 2 story, 40 x 150 ft. addition to present heating apparatus factory here. About $150,000.

Ia., Webster City—The Webster City Stock Co. is having plans prepared for a 6 story hotel and store building including a steam heating system. About $300,000. Proudfoot, Bird & Rawson, 810 Hubbell Bldg., Des Moines, Archts.

Minn., Minneapolis—The Bd. Educ. had plans prepared for a 4 story, 220 x 300 ft. senior high school, including a steam heating system on 20th Ave. and Quincy St. About $700,000. E. H. Enger, 3018 3rd Ave. S., Archt.

Minn., Minneapolis—The Bd. Educ. is having plans prepared for a 3 story junior high school, including a steam heating system, on 30th Ave. N. and Emerson Ave. About $600,000. E. H. Enger, 3018 3rd Ave. S., Archt.

Neb., Lincoln—The State Legislature of Lincoln plans to construct a 5 or 6 story capitol building including a steam heating system. About $7,000,000. Bertram G. Goodhue, 2 West 47th St., New York City, Archt. and Engr.

Mont., Polson—The Rocky Mountain Power Co. of Butte has filed an application at the office of the federal register of lands, for preliminary power permit to construct 5 dams in the Flathead River between northeast corner of the Bison range and point where river enters the lake near here.

Mo., Kansas City—The Kansas City Light & Power Co. plans to install 5 new substations in the down-town dist. between Oak and Wyandotte Sts. and 7th and 15th Sts. The stations will be equipped with automatic motor generator sets for converting a.c. to d.c. The first station will be located in the R. A. Long Bldg. on 10th and Grand Aves., and equipment will include one standard 1,500 kw. rotary. Estimated cost, $500,000.

Mo., Moberly—The city plans to construct a pumping plant, etc. About $250,000. Fuller & Beard, Chemical Bldg., St. Louis, Engrs.

Tex., Port Arthur—The Eastern Texas Electric Co. plans to build a generating station extension and install a 4,000 kw. turbo generator, two 665 hp. boilers with auxiliary equiment and pumps. About $600,000. Joseph Bowers, Supt. Stone & Webster Inc., 147 Milk St., Boston, Mass., Engrs.

Cal., Brawley—The city plans to build a 1 story, 60 x 80 ft. power plant along the water front. Two 100 hp. Diesel engines and two 100 hp. motors, two 850 g.p.m. centrifugal pumps will be installed in same. About $15,000. G. R. Wade, City Engr.

Cal., Mare Island—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will soon receive bids for the installation of a heating system in the structural shop here. Noted May 18.

Ont., Chatham—The city is having plans prepared for altering pumphouse, including the installation of electrical driven centrifugal pumps, etc. About $50,000. E. A. James Co., Ltd., 36 Toronto St., Toronto, Engr.

Ont., Hamilton—The city has voted upon $15,000 bonds to construct an electric light plant.

Ont., Port Arthur—The Kaministiquia Pulp & Paper Co. plans to construct a pulp mill. A hydro-electric plant will probably be installed in same. About $1,000,000. C. D. Howe, Engr.

CONTRACTS AWARDED

N. H., Portsmouth—The Portsmouth Hospital has awarded the contract for a 2 story, 30 x 150 ft. boiler house, laundry, etc., to H. A. Wood, 21 Brewster St., at $25,000. Noted June 29.

Mass., Belchertown—The Committee on Mental Diseases, 36 State House, Boston, has awarded the contract for installing a heating system in the proposed hospital buildings at the State Hospital here, to the Holyoke Valve & Hydrant Co., Race St., Holyoke, at $21,483. Noted July 6.

Mass., Boston—The New Boston Arena Co., c/o Frank & Wilcox, Archts., 294 Washington St., has awarded the contract for a 1 and 2 story auditorium building, including a steam heating plant on St. Botolph St., to the W. M. Bailey Co., 88 Broad St., at $800,000.

Mass., Fall River—The Osborn Mills, Montaup St., has awarded the contract for a two story sub-station, to Beattie & Connell, 33 North Quarry St., at $25,000.

Mass., Malden—The Standard Oil Co. of New York, 26 B'way, New York City, has awarded the contract for a 1 story, 60 x 102 ft. warehouse and a 1 story, 60 x 132 ft. boiler house, to H. D. Best, 175 5th Ave., New York City.

Mass., Somerville (Boston P. O.)—The Great Atlantic & Pacific Tea Co., 451 D St., South Boston, has awarded the contract for a 5 story 100 x 370 ft. warehuse, including a steam heating system here, to the Turner Constr. Co., 178 Tremont St., Boston, at $650,000.

Conn., Hartford—The Hartford Auto Club Garage Co., 36 Race St., will build a 7 story, 147 x 150 ft. garage, etc., including a steam heating system on Hicks and South Ann Sts. About $500,000. Work will be done by day labor. C. F. Luce, 36 Pearl St., Archt.

N. Y., Long Island City—Stein Hall & Co., Inc., 61 B'way, New York City, has awarded the contract for a 4 story factory, including a steam heating system, on 6th and Jackson Aves., to the Turner Constr. Co., 244 Madison Ave. About $400,000.

N. Y., Oneida—The Standard Oil Co. of New York has awarded the contact for a 1 story, 23 x 60 ft. garage, 15 x 20 ft. boiler house, 12 x 16 ft. pump house, including steam heating system, to H. D. Best, 175 5th Ave., New York City, at $35,000.

N. Y., Syracuse—The Standard Oil Co. of New York, 26 B'way, New York City, has awarded the contract for a 2 story, 100 x 140 ft. warehouse, 1 story, 40 x 55 ft. tank house, 1 story, 36 x 90 ft. boiler and pump house and a 1 story, 60 x 120 ft. garage, to H. D. Best, 175 5th Ave., New York City.

N. J., Newark—The Peerless Baking Co., 713 South 14th St., has awarded the contract for a 2 story, 50 x 100 ft. factory and power house, on Nye Ave. and Clinton Pl., to the United Fireproofing Co., 8 West 40th St., New York City.

Tenn., Memphis—The Iten Biscuit Co., 1202-24 Capitol Ave., Omaha, Neb., has awarded the contract for an 8 story, 290 x 450 ft. biscuit factory, including a steam heating system here, to the Alexander Constr. Co., 388 North Front St. About $500,000.

Tenn., Nashville—The Waterworks Dept. has awarded the contract for two 20,000,000 gal. capacity high service pumps and two 20,000,000 gal. capacity low service pumps, to the Worthington Pump Co., at $180,950. Noted June 29.

O., Cleveland—The Eaton Axle Co., 10307 Euclid Ave., has awarded the contract for a 1 story, 62 x 123 ft. heat treating plant and boiler room at 831 East 140th St., to the Lundoff-Bicknell Co., 5716 Euclid Ave., at $50,000.

O., East Cleveland (Cleveland P. O.)—The Cleveland Electric Illuminating Co., Illuminating Bldg., Cleveland, has awarded the contract for a 1 story, 43 x 49 ft. electric sub-station addition at 16301 Euclid Ave., to F. E. Hauselman, 408 Illuminating Bldg., Cleveland, at $50,000.

Ill., Belleville—The Arcade Theatre Co. has awarded the contract for a 3 story, 80 x 175 ft. theatre, including a low pressure steam heating system, on Main and High Sts., to the Mullen Bldg. Corp. About $250,000.

Ill., Mt. Vernon—Swift & Co., United States Yards, Chicago, has awarded the contract for a 2 story warehouse and cold storage building, to Theo. Stark & Co., Cedar Rapids, Ia., at $165,000.

Ill., Rockford—The city has awarded the contract for furnishing and installing an air compressor, in connection with the proposed concrete reservoir on Stanley and Cedar Sts., to the Swords Bros. Co., 17th St., at $30,470.

Ia., Muscatine—E. M. Henle will build a 5 story, 120 x 140 ft. theatre and store building, including a steam heating system. About $527,000. Work will be done by day labor.

Kan., Paola—The city has awarded the contract for installing pumps, to the Williamson Pump & Machine Co., Kansas City, Mo., at $14,690.

Ont., Kitchener—The Paramount Theatres, Temple Bldg., has awarded the contract for a 1 and 2 story motion picture theatre, including a vacuum steam heating system with mechanical ventilation system, on Queen St., to B. H. Secord & Sons, 133 Nelson St., Brantford, at $300,000.

NEED COMPETENT MEN?
SEE THE SEARCHLIGHT SECTION
Pages 92 to 105 **Pages 92 to 105**